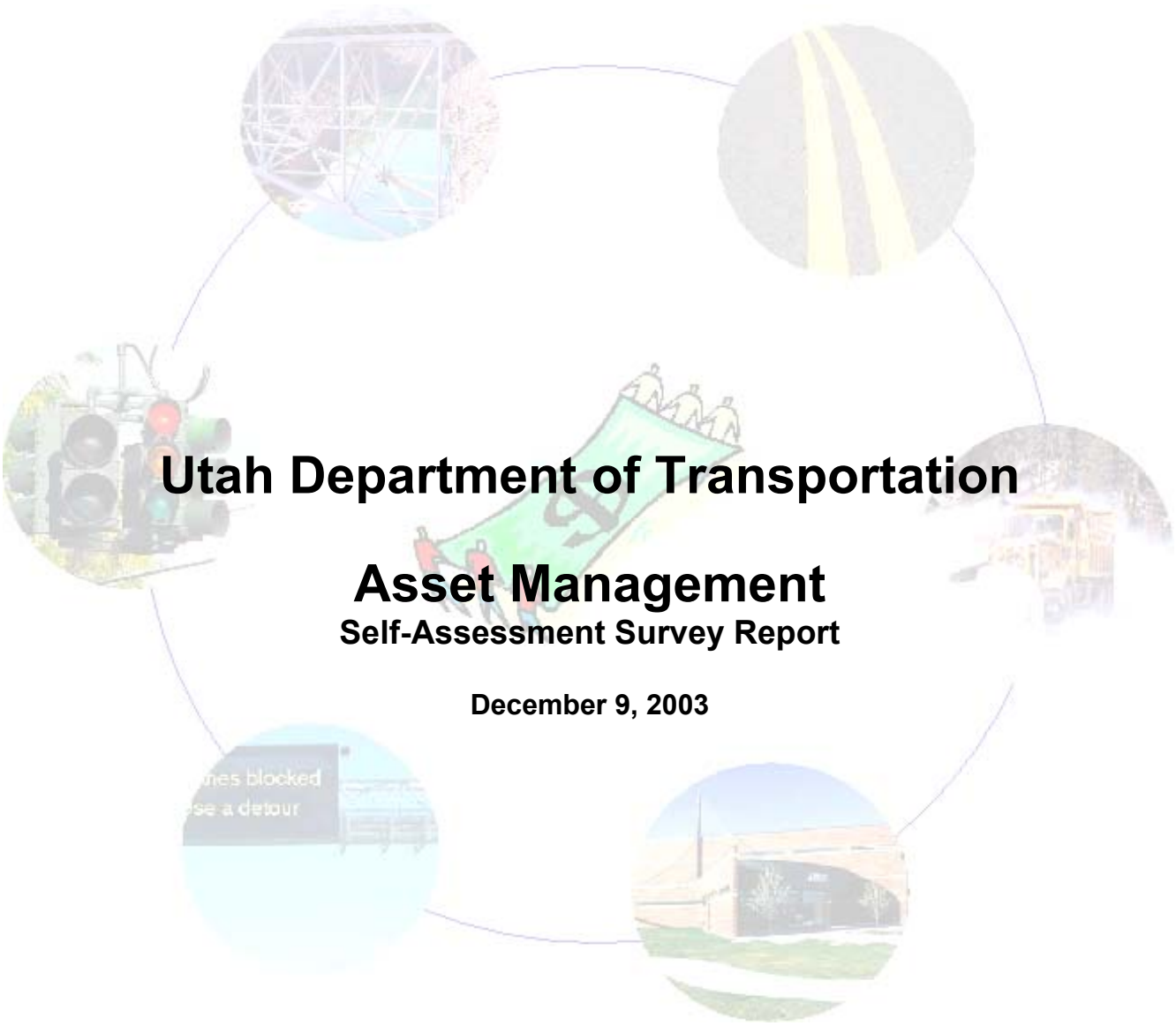

Utah Department of Transportation

Asset Management

Self-Assessment Survey Report

December 9, 2003

Prepared by:

UDOT CONNECTING COMMUNITIES

Asset Management Team

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1. Introduction

1.1 History

During the past six years, the Federal Highway Administration (FHWA) and the National Highway Cooperative Research Program (NCHRP) has produced some groundbreaking documents for the Transportation Asset Management efforts throughout the nation. One of these is titled "Transportation Asset Management Guide", also known as report NCHRP 20-24(11). It contains a self-assessment survey for the purpose of characterizing asset management practices and identifying specific opportunities for improvement within a state department of transportation.

According to the Guide, the survey helps a state DOT to:

1) Develop a consensus among managers regarding the status of asset management.

2) Identify strengths, weaknesses, constraints, and opportunities for improvement in asset management.

3) Develop priorities and recognize critical areas that need immediate attention

4) Provide a foundation for developing and implementing an asset management improvement strategy and implementation plan.

1.2 Respondents

The survey was sent by e-mail from the Assistant Director, Carlos Braceras, to 57 employees within four respondent groups. 48 employees responded and they are listed below.

- Senior Management (8 of 10)
  - Carlos Braceras, Chuck Larsen, Jim McMinimee, Max Ditlevsen, Ahmad Jaber, Randy Park, Tracy Conti, Dal Hawks
- Regions (13 of 16)
  - Nathan Lee, Val Stoker, Dave Blake, Lori Porter, Grant Wiley, PattiJo Toomer, James Cox, Hugh Kirkham, Robert Dowell, Scott Goodwin, Gaye Babcock, Richard Anderson, Scott Munson
- Asset Groups (17 of 19)
  - Lyle McMillen, Karen Stein, Craig Fox, Lloyd Neeley, Austin Baysinger, Alan McEwan, Dave Nazare, Dave Eixenberger, Dan Adams, Justin Jar, Richard Miller, Mike Marz, Robert Hull, Peter Tang, John Leonard, Dave Kinnecom, Sterling Davis
- Planning, IT, and Asset Management (10 of 12)
  - John Quick, John Thomas, Kevin Nichol, Matt Swapp, Elden Bingham, Walter Steinvorth, Chris Glazier, Dave Burton, Kim Schvaneveldt, Glen Ames

2. Collection and Analysis

Survey collection and analysis were performed in a three-stage process. First, individual responses were entered and summaries were created for each question. Then, summaries were generated for each question group and respondent group. Finally, the results for each question were analyzed. The percentages for "1" and "2" were grouped together and as well as the percentages for "4" and "5". This reduced the results to three groups: negative support (1&2), neutral support (3) and positive support (4&5).

The overall group of respondents was analyzed as an average of the four respondent groups. In other words, respondent group percentages were averaged to obtain overall group percentages. Each group therefore contributed an equal fourth to the overall score, resulting in a fair and objective analysis.

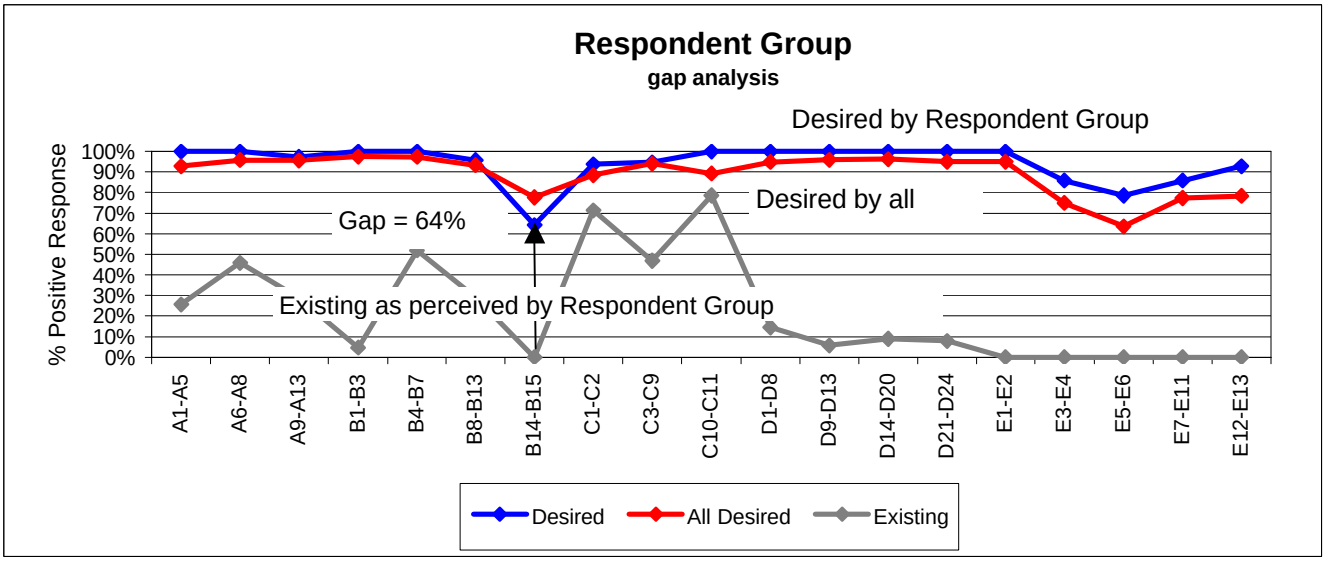
After the respondent group and question group summaries were generated, gap analysis charts and tables were created for each respondent group. Figure 1 shows a gap analysis example. The blue line shows the respondent group's desired level, in terms of responses that were either "4" or "5". The gray line shows their perceived level of existing implementation, also in terms of responses that were either "4" or "5". The red line shows the average desired level of implementation for all respondents. These charts, along with the numerical data will be presented in section 4.0.

The charts are interpreted by looking at the gap between the gray line and the blue line. For example, there is a difference of 45% between the respondent group's perceived level of existing implementation for the question group B4-B7 and their desired level of implementation. The larger the gap is, the more work there is to be done to reach the desired level. The table beneath the chart shows the descriptions of the question groups along with the actual data for the chart. The "Top 10" high priority areas are highlighted. These areas are comprised of the lowest five desired and the highest five gaps.

After a respondent group studies its gap analysis, it should improve its high priority areas through education and/or an improvement in its work. For example, question group D1-D8, which pertains to effective and efficient data collection, needs to be addressed by the respondent group in Figure 1. If the group is Planning, IT, and AM it may perceive itself as having less control than the asset groups, who actually do the collecting. However, since planning is a primary user of cross-asset data, they can play a strong role in the improvement of data collection through clear communication of needs with asset groups. **In other words, each respondent group can take responsibility for its high priority areas and improve them, regardless of "boundary" perceptions. Since all four groups have common and integrated interests, they can all play a role in the improvement of each asset management area.**

2. Collection and Analysis

Figure 2.1 Example Gap Analysis



Question Group (Top 5 gaps and lowest 5 desired are highlighted)	Existing	Desired	All Desired	Gap
Policy guidance benefiting from good asset management (A1-A5)	26%	100%	93%	74%
Strong framework for performance based resource allocation (A6-A8)	46%	100%	96%	54%
Proactive role in policy formulation (A9-A13)	29%	97%	96%	68%
Consideration of alternatives in planning and programming (B1-B3)	5%	100%	97%	95%
Performance based planning and clear linkage among policy, planning, and programming (B4-B7)	52%	100%	97%	48%
Performance based programming process (B8-B13)	29%	96%	93%	66%
Ensuring the proper state transportation network (B14-B15)	0%	64%	78%	64%
Consideration of alternative project delivery mechanisms (C1-C2)	71%	94%	88%	22%
Effective program management (C3-C9)	47%	95%	94%	48%
Cost tracking and estimating (C10-C11)	79%	100%	89%	21%
Effective and efficient data collection (D1-D8)	15%	100%	94%	85%
Information integration and access (D9-D13)	6%	100%	96%	94%
Use of decision support tools (D14-D20)	9%	100%	96%	91%
System monitoring and feedback (D21-D24)	8%	100%	95%	92%
Support of asset management team initiatives (E1-E2)	0%	100%	98%	100%
Asset management team responsibilities (E3-E4)	0%	86%	75%	86%
Funding allocations from x-asset optimization used from LRP to tactical/operational areas (E5-E6)	0%	79%	66%	79%
Asset management team coord. w/ management systems and tactical/operational areas (E7-E11)	0%	86%	77%	86%
Asset management team will share knowledge w/ other trans. agencies and local gov'ts (E12-E13)	0%	93%	78%	93%

3. Summarized Results

The summarized survey results will now be presented in four sections, corresponding to the respondent groups. The next section will examine the survey results in a detailed manner and discuss key issues and groups that can help improve asset management. Figure 2 shows the complete survey summary, showing the results for respondent groups and question groups.

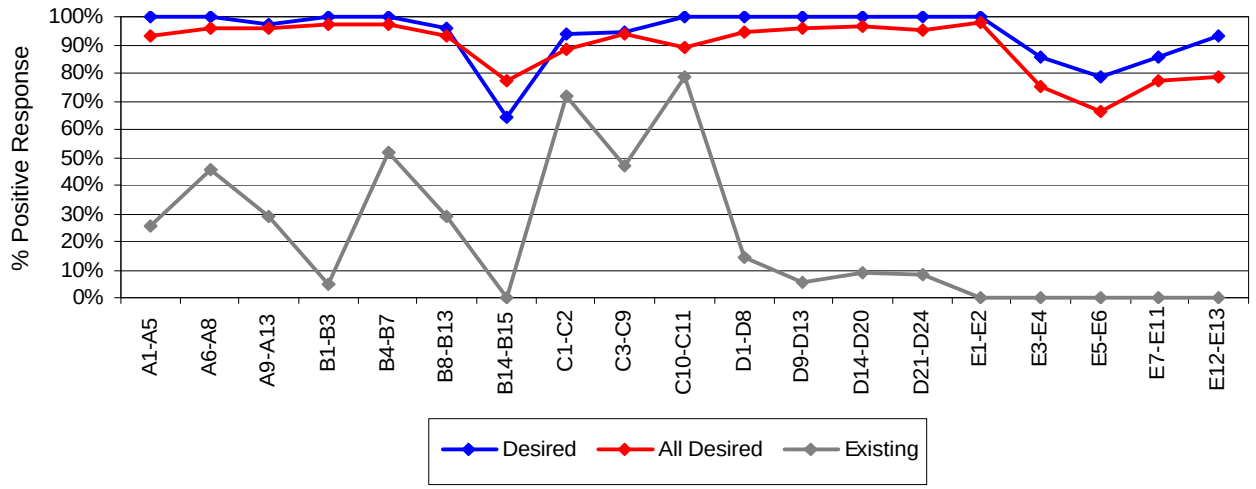
Figure 2.2 Summarized Results

			Senior			Region			Asset Groups			PL, IT, AM			All Respondents			
			1+2	3	4+5	1+2	3	4+5	1+2	3	4+5	1+2	3	4+5	1+2	3	4+5	Question Group
Policy Guidance	A1-A5	E	28%	46%	26%	20%	46%	34%	37%	29%	34%	27%	35%	38%	28%	39%	33%	POLICY GUIDANCE BENEFITING FROM GOOD ASSET MANAGEMENT
		D	0%	0%	100%	3%	12%	86%	0%	7%	93%	2%	6%	92%	1%	6%	93%	
		A		15%			11%			11%			20%			14%	
	A6-A8	E	25%	29%	46%	38%	33%	28%	29%	42%	29%	34%	24%	41%	32%	32%	36%	STRONG FRAMEWORK FOR PERFORMANCE-BASED RESOURCE ALLOCATION
		D	0%	0%	100%	0%	7%	93%	0%	9%	91%	0%	0%	100%	0%	4%	96%	
		A		17%			26%			13%			3%			15%	
	A9-A13	E	34%	37%	29%	26%	38%	36%	39%	23%	38%	43%	27%	31%	36%	31%	33%	PROACTIVE ROLE IN POLICY FORMULATION
		D	3%	0%	97%	1%	9%	90%	0%	5%	95%	0%	0%	100%	1%	4%	95%	
		A		5%			13%			19%			12%			12%	
Planning / Programming	B1-B3	E	43%	52%	5%	41%	49%	10%	36%	37%	28%	33%	37%	30%	36%	44%	18%	CONSIDERATION OF ALTERNATIVES IN PLANNING AND PROGRAMMING
		D	0%	0%	100%	0%	2%	98%	0%	0%	100%	0%	7%	93%	0%	2%	98%	
		A		0%			5%			8%			7%			5%	
	B4-B7	E	30%	19%	52%	26%	44%	30%	14%	25%	61%	22%	27%	51%	23%	29%	48%	PERFORMANCE BASED PLANNING AND CLEAR LINKAGE AMONG POLICY, PLANNING AND PROGRAMMING
		D	0%	0%	100%	0%	4%	96%	0%	7%	93%	0%	0%	100%	0%	3%	97%	
		A		0%			5%			24%			10%			10%	
	B8-B13	E	32%	39%	29%	50%	36%	14%	29%	33%	38%	19%	43%	39%	32%	38%	30%	PERFORMANCE BASED PROGRAMMING PROCESS
		D	0%	4%	96%	0%	6%	94%	0%	5%	95%	0%	11%	89%	0%	7%	93%	
		A		9%			11%			21%			20%			15%	
	B14-B15	E	83%	17%	0%	52%	40%	8%	50%	29%	21%	53%	32%	16%	59%	29%	11%	ENSURING THE PROPER STATE TRANSPORTATION NETWORK
		D	7%	29%	64%	7%	11%	81%	4%	19%	77%	0%	11%	89%	5%	17%	78%	
		A		0%			4%			6%			5%			4%	
Program Delivery	C1-C2	E	21%	7%	71%	14%	46%	39%	13%	40%	47%	16%	21%	63%	16%	29%	55%	CONSIDERATION OF ALTERNATIVE PROJECT DELIVERY MECHANISMS
		D	0%	6%	94%	7%	14%	79%	0%	7%	93%	0%	11%	89%	2%	9%	89%	
		A		25%			32%			34%			30%			30%	
	C3-C9	E	20%	33%	47%	32%	32%	36%	37%	21%	42%	12%	38%	50%	25%	31%	44%	EFFECTIVE PROGRAM MANAGEMENT
		D	0%	5%	95%	2%	8%	90%	0%	3%	97%	0%	5%	95%	1%	5%	94%	
		A		23%			22%			30%			29%			26%	
	C10-C11	E	14%	7%	79%	19%	35%	46%	25%	42%	33%	18%	35%	47%	19%	30%	51%	COST TRACKING AND ESTIMATING
		D	0%	0%	100%	4%	15%	81%	0%	12%	88%	0%	12%	88%	1%	10%	90%	
		A		25%			33%			19%			25%			26%	
Info Analysis	D1-D8	E	47%	36%	15%	24%	38%	37%	36%	31%	34%	33%	25%	43%	35%	33%	32%	EFFECTIVE AND EFFICIENT DATA COLLECTION
		D	0%	0%	100%	3%	4%	93%	1%	6%	93%	0%	8%	93%	1%	4%	95%	
		A		8%			23%			26%			25%			20%	
	D9-D13	E	63%	31%	6%	51%	34%	15%	52%	35%	13%	58%	28%	14%	66%	32%	12%	INFORMATION INTEGRATION AND ACCESS
		D	0%	0%	100%	0%	3%	97%	1%	6%	93%	0%	6%	94%	0%	4%	96%	
		A		5%			30%			10%			16%			15%	
	D14-D20	E	60%	31%	9%	51%	37%	12%	56%	31%	13%	48%	32%	20%	54%	33%	13%	USE OF DECISION SUPPORT TOOLS
		D	0%	0%	100%	0%	3%	97%	0%	4%	96%	0%	7%	93%	0%	4%	96%	
		A		0%			23%			13%			18%			14%	
	D21-D24	E	44%	48%	8%	60%	28%	12%	57%	38%	5%	53%	33%	14%	53%	37%	10%	SYSTEM MONITORING AND FEEDBACK
		D	0%	0%	100%	0%	7%	93%	0%	7%	93%	0%	5%	95%	0%	5%	95%	
		A		0%			9%			2%			13%			8%	
AM Implement	E1-E2	D			100%			88%			96%			88%			93%	SUPPORT OF ASSET MANAGEMENT TEAM AND INITIATIVES
	E3-E4	D	7%	7%	86%	11%	32%	57%	19%	16%	66%	0%	5%	95%	9%	15%	76%	AM TEAM RESPONSIBILITIES
	E5-E6	D	14%	7%	79%	36%	14%	50%	13%	28%	59%	5%	25%	70%	17%	19%	64%	FUNDING ALLOCATIONS FROM CROSS-ASSET OPTIMIZATION APPLIED FROM LRP TO TACTICAL/OPERATIONAL
	E7-E11	D	3%	11%	86%	10%	26%	63%	6%	20%	73%	4%	10%	86%	6%	17%	77%	AM TEAM COORDINATION WITH MANAGEMENT SYSTEMS AND TACTICAL / OPERATIONAL AREAS
	E12-E13	D	0%	7%	93%	8%	31%	62%	13%	28%	59%	0%	5%	95%	5%	18%	77%	AM TEAM WILL SHARE KNOWLEDGE WITH OTHER TRANSPORTATION AGENCIES AND LOCAL GOVERNMENTS

3. Summarized Results

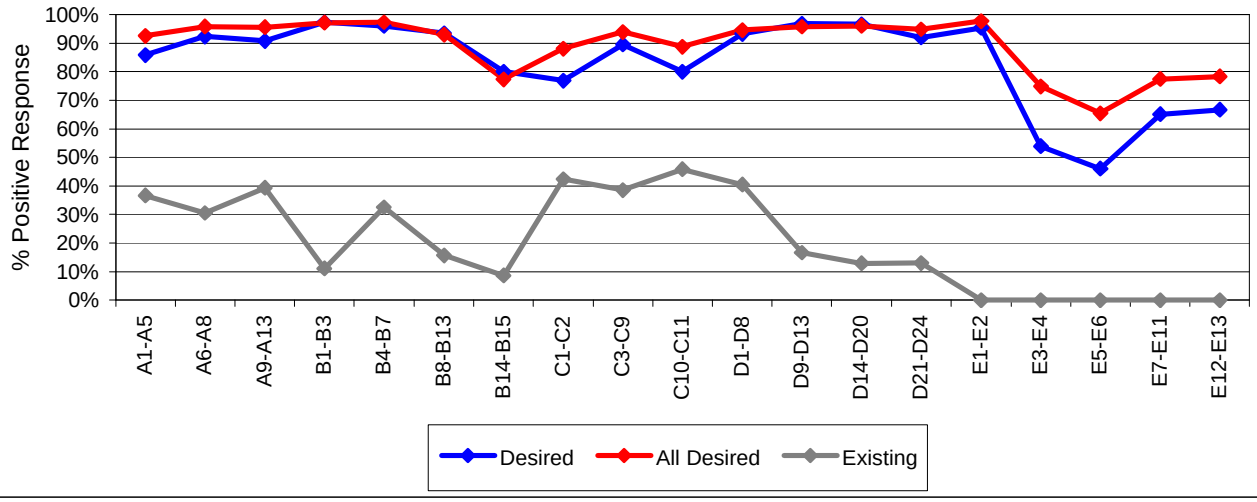
Senior Management

Figure 3.1 Senior Management Gap Analysis



Question Group (Top 5 gaps and lowest 5 desired are highlighted)	Existing	Desired	All Desired	Gap
Policy guidance benefiting from good asset management (A1-A5)	26%	100%	93%	74%
Strong framework for performance based resource allocation (A6-A8)	46%	100%	96%	54%
Proactive role in policy formulation (A9-A13)	29%	97%	96%	68%
Consideration of alternatives in planning and programming (B1-B3)	5%	100%	97%	95%
Performance based planning and clear linkage among policy, planning, and programming (B4-B7)	52%	100%	97%	48%
Performance based programming process (B8-B13)	29%	96%	93%	66%
Ensuring the proper state transportation network (B14-B15)	0%	64%	78%	64%
Consideration of alternative project delivery mechanisms (C1-C2)	71%	94%	88%	22%
Effective program management (C3-C9)	47%	95%	94%	48%
Cost tracking and estimating (C10-C11)	79%	100%	89%	21%
Effective and efficient data collection (D1-D8)	15%	100%	94%	85%
Information integration and access (D9-D13)	6%	100%	96%	94%
Use of decision support tools (D14-D20)	9%	100%	96%	91%
System monitoring and feedback (D21-D24)	8%	100%	95%	92%
Support of asset management team initiatives (E1-E2)	0%	100%	98%	100%
Asset management team responsibilities (E3-E4)	0%	86%	75%	86%
Funding allocations from x-asset optimization used from LRP to tactical/operational areas (E5-E6)	0%	79%	66%	79%
Asset management team coord. w/ management systems and tactical/operational areas (E7-E11)	0%	86%	77%	86%
Asset management team will share knowledge w/ other trans. agencies and local gov'ts (E12-E13)	0%	93%	78%	93%

Figure 3.2 Regions Gap Analysis

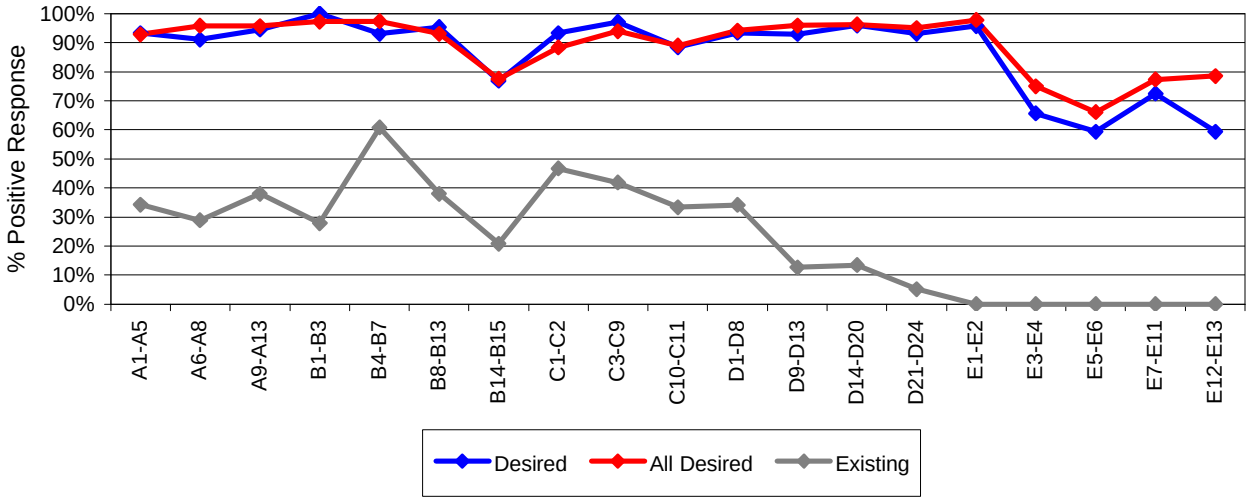


Question Group (Top 5 gaps and lowest 5 desired are highlighted)	Existing	Desired	All Desired	Gap
Policy guidance benefiting from good asset management (A1-A5)	34%	86%	93%	52%
Strong framework for performance based resource allocation (A6-A8)	28%	93%	96%	65%
Proactive role in policy formulation (A9-A13)	36%	90%	96%	54%
Consideration of alternatives in planning and programming (B1-B3)	10%	98%	97%	87%
Performance based planning and clear linkage among policy, planning, and programming (B4-B7)	30%	96%	97%	66%
Performance based programming process (B8-B13)	14%	94%	93%	79%
Ensuring the proper state transportation network (B14-B15)	8%	81%	78%	73%
Consideration of alternative project delivery mechanisms (C1-C2)	39%	79%	88%	39%
Effective program management (C3-C9)	36%	90%	94%	55%
Cost tracking and estimating (C10-C11)	46%	81%	89%	35%
Effective and efficient data collection (D1-D8)	37%	93%	94%	55%
Information integration and access (D9-D13)	15%	97%	96%	82%
Use of decision support tools (D14-D20)	12%	97%	96%	85%
System monitoring and feedback (D21-D24)	12%	93%	95%	81%
Support of asset management team initiatives (E1-E2)	0%	88%	98%	88%
Asset management team responsibilities (E3-E4)	0%	57%	75%	57%
Funding allocations from cross-asset optimization used from LRP to tactical/operational areas (E5-E6)	0%	50%	66%	50%
Asset management team coord. w/ management systems and tactical/operational areas (E7-E11)	0%	63%	77%	63%
Asset management team will share knowledge w/ other trans. agencies and local gov'ts (E12-E13)	0%	62%	78%	62%

3. Summarized Results

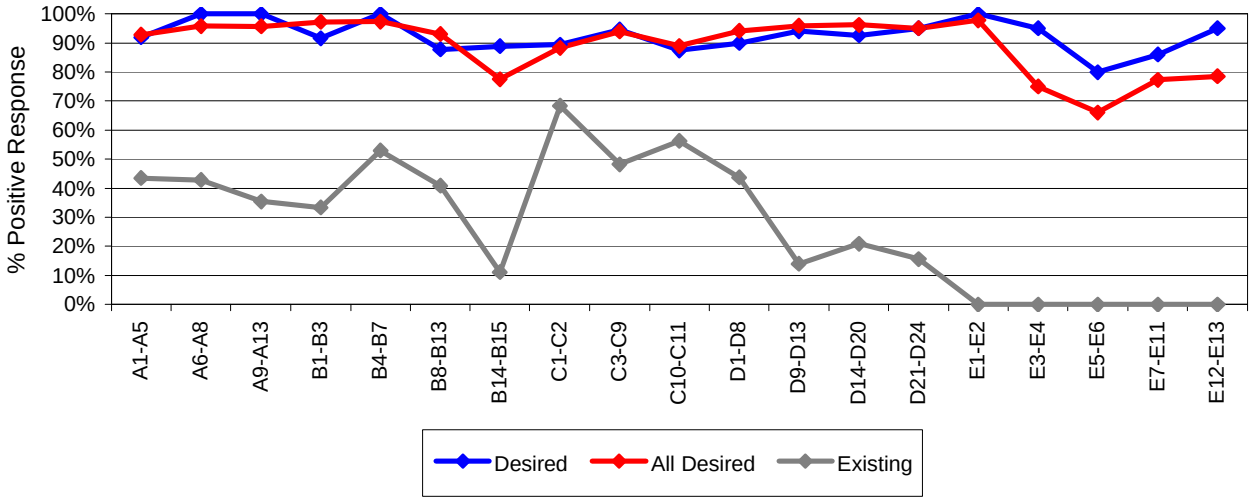
Asset Groups

Figure 3.3 Asset Groups Gap Analysis



Question Group (Top 5 gaps and lowest 5 desired are highlighted)	Existing	Desired	All Desired	Gap
Policy guidance benefiting from good asset management (A1-A5)	34%	93%	93%	59%
Strong framework for performance based resource allocation (A6-A8)	29%	91%	96%	67%
Proactive role in policy formulation (A9-A13)	38%	95%	96%	58%
Consideration of alternatives in planning and programming (B1-B3)	28%	100%	97%	69%
Performance based planning and clear linkage among policy, planning, and programming (B4-B7)	61%	93%	97%	37%
Performance based programming process (B8-B13)	38%	95%	93%	55%
Ensuring the proper state transportation network (B14-B15)	21%	77%	78%	57%
Consideration of alternative project delivery mechanisms (C1-C2)	47%	93%	88%	42%
Effective program management (C3-C9)	42%	97%	94%	52%
Cost tracking and estimating (C10-C11)	33%	88%	89%	56%
Effective and efficient data collection (D1-D8)	34%	93%	94%	60%
Information integration and access (D9-D13)	13%	93%	96%	83%
Use of decision support tools (D14-D20)	13%	96%	96%	83%
System monitoring and feedback (D21-D24)	5%	93%	95%	90%
Support of asset management team initiatives (E1-E2)	0%	96%	98%	98%
Asset management team responsibilities (E3-E4)	0%	66%	75%	75%
Funding allocations from cross-asset optimization used from LRP to tactical/operational areas (E5-E6)	0%	59%	66%	66%
Asset management team coord. w/ management systems and tactical/operational areas (E7-E11)	0%	73%	77%	77%
Asset management team will share knowledge w/ other trans. agencies and local gov'ts (E12-E13)	0%	59%	78%	78%

Figure 3.4 Planning, IT, and AM Gap Analysis

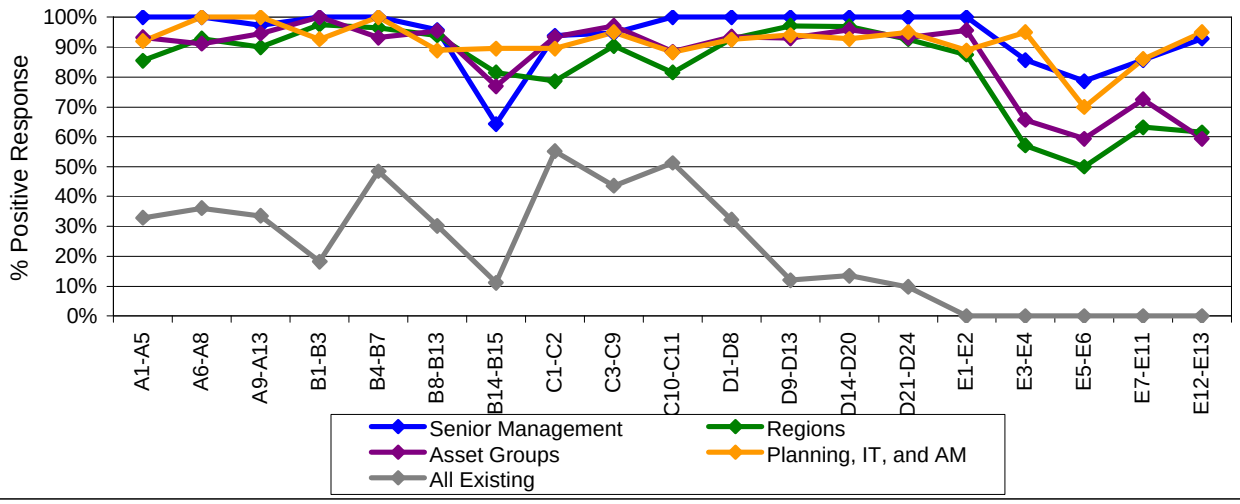


Question Group (Top 5 gaps and lowest 5 desired are highlighted)	Existing	Desired	All Desired	Gap
Policy guidance benefiting from good asset management (A1-A5)	38%	92%	93%	55%
Strong framework for performance based resource allocation (A6-A8)	41%	100%	96%	59%
Proactive role in policy formulation (A9-A13)	31%	100%	96%	69%
Consideration of alternatives in planning and programming (B1-B3)	30%	93%	97%	63%
Performance based planning and clear linkage among policy, planning, and programming (B4-B7)	51%	100%	97%	49%
Performance based programming process (B8-B13)	39%	89%	93%	50%
Ensuring the proper state transportation network (B14-B15)	16%	89%	78%	74%
Consideration of alternative project delivery mechanisms (C1-C2)	63%	89%	88%	26%
Effective program management (C3-C9)	50%	95%	94%	45%
Cost tracking and estimating (C10-C11)	47%	88%	89%	41%
Effective and efficient data collection (D1-D8)	43%	93%	94%	50%
Information integration and access (D9-D13)	14%	94%	96%	80%
Use of decision support tools (D14-D20)	20%	93%	96%	73%
System monitoring and feedback (D21-D24)	14%	95%	95%	81%
Support of asset management team initiatives (E1-E2)	0%	89%	98%	89%
Asset management team responsibilities (E3-E4)	0%	95%	75%	95%
Funding allocations from cross-asset optimization used from LRP to tactical/operational areas (E5-E6)	0%	70%	66%	70%
Asset management team coord. w/ management systems and tactical/operational areas (E7-E11)	0%	86%	77%	86%
Asset management team will share knowledge w/ other trans. agencies and local gov'ts (E12-E13)	0%	95%	78%	95%

3. Summarized Results

All Respondent Groups

Figure 3.5 All Respondent Groups Gap Analysis



Question Group	Senior Management	Regions	Asset Groups	Planning, IT, and AM
Policy guidance benefiting from good asset management (A1-A5)				
Strong framework for performance based resource allocation (A6-A8)			X	
Proactive role in policy formulation (A9-A13)				
Consideration of alternatives in planning and programming (B1-B3)	X	X	X	X
Performance based planning and clear linkage among policy, planning, and programming (B4-B7)				
Performance based programming process (B8-B13)		X		O
Ensuring the proper state transportation network (B14-B15)	O		O	X
Consideration of alternative project delivery mechanisms (C1-C2)		O		
Effective program management (C3-C9)				
Cost tracking and estimating (C10-C11)				O
Effective and efficient data collection (D1-D8)	X			
Information integration and access (D9-D13)	X	X	X	X
Use of decision support tools (D14-D20)	X	X	X	X
System monitoring and feedback (D21-D24)	X	X	X	X
Support of asset management team initiatives (E1-E2)				O
Asset management team responsibilities (E3-E4)	O	O	O	
Funding allocations from cross-asset optimization used from LRP to tactical/operational areas (E5-E6)	O	O	O	O
Asset management team coord. w/ management systems and tactical/operational areas (E7-E11)	O	O	O	O
Asset management team will share knowledge w/ other trans. agencies and local gov'ts (E12-E13)	O	O	O	

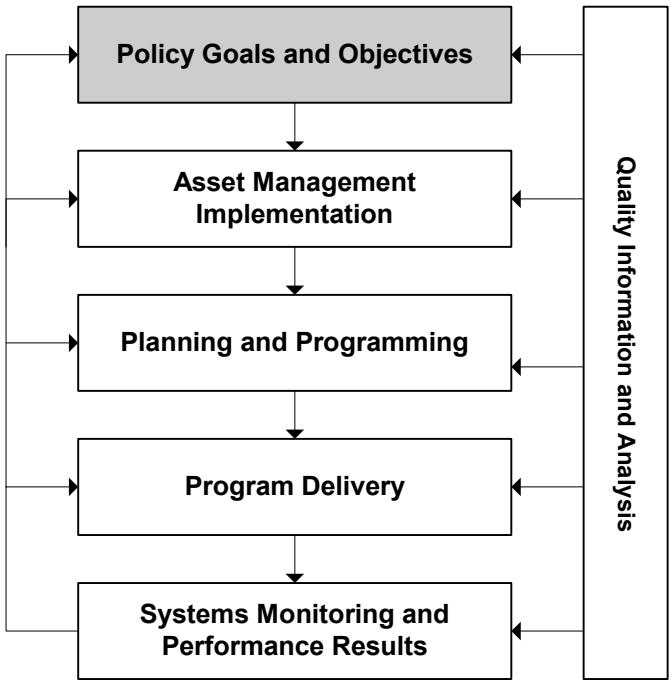
X = largest gaps
O = lowest desired

4.A Policy Guidance

Overview: The role of Policy Guidance is to establish clear direction for the remaining functions of UDOT. Planning, priority programming, program delivery, and system monitoring all must be aligned with policy objectives and associated performance measures for better decision-making and resource allocation.

Asset Management is a policy-driven process that has specific goals and provides a framework for institutionalizing an effective business process.

Figure A. Resource Allocation and Utilization – Policy Goals and Objectives

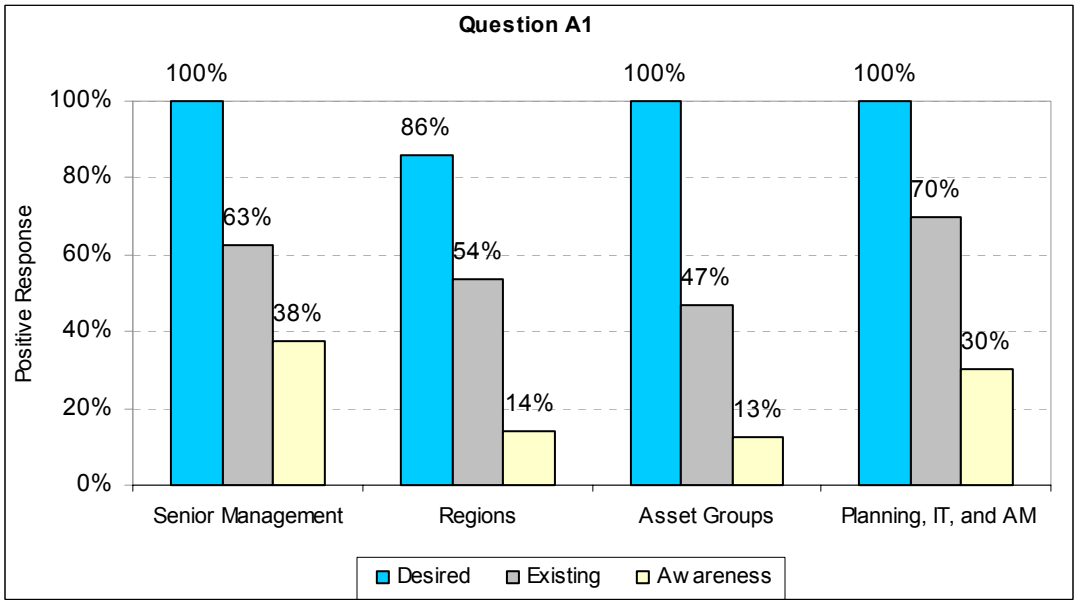


Asset Management Areas

- **Role of Policy Guidance**
- **Improved Policy-Making**
- **Relating Policy to Performance**
- **Playing a Proactive Role in Policy Formulation**

Policy Guidance benefiting from good Asset Management

Figure A1. Policy guidance supports preservation of existing infrastructure assets.



Discussion:

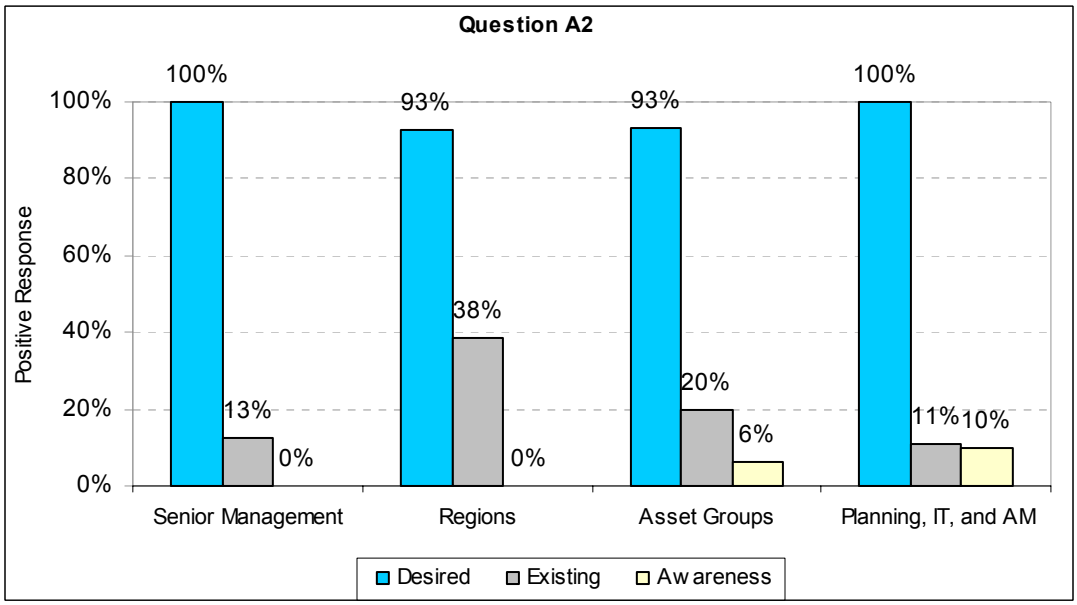
Departmental policy must clearly favor preservation strategies over replacement strategies for existing infrastructure assets. All levels within the department must strive for the efficient preservation of existing assets wherever possible and communicate the importance of this policy on a routine basis.

Initiatives to be developed in Asset Management Strategy:

- UDOT must formalize, approve and adopt an official Preservation Policy.
- UDOT must communicate this policy to all UDOT employees and stakeholders.

Timeline:	**Responsibility:**
Immediate	TRANSMAT

Figure A2. Policy guidance encourages resource allocation and project selection based upon cost-effectiveness or benefit-cost analysis.



Discussion:

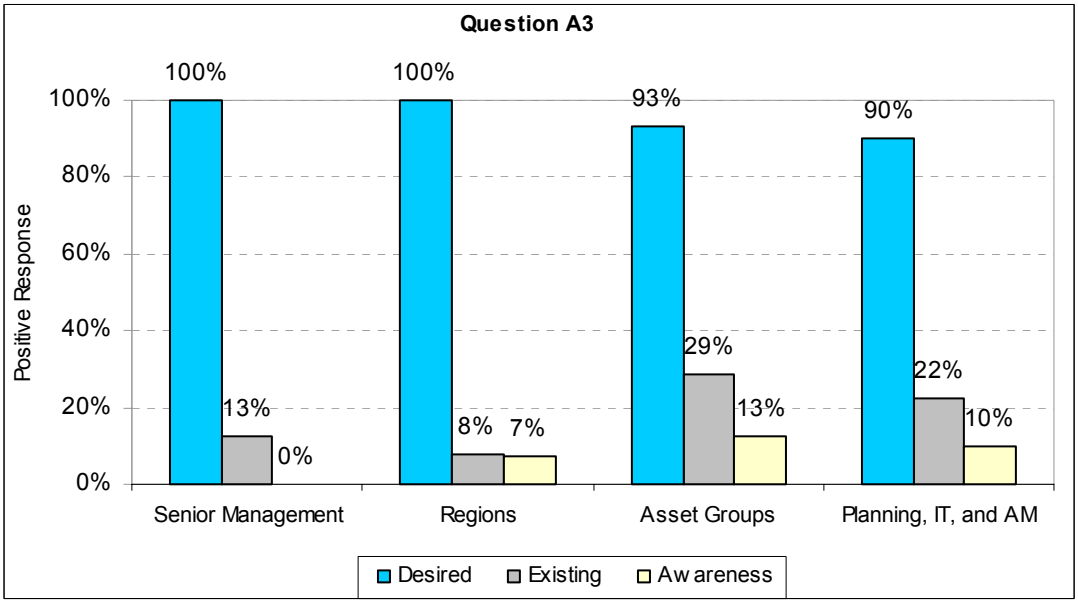
Departmental policy must clearly favor and encourage resource allocation based upon cost-effectiveness and / or benefit – cost analysis.

Initiatives to be developed in Asset Management Strategy:

- UDOT must formalize, approve and adopt an official Preservation Policy.
- UDOT must communicate this policy to all UDOT employees and stakeholders.

Timeline:	Responsibility:
Immediate	TRANSMAT

Figure A3: Policies support a long-term, life–cycle approach to evaluating investment benefits and costs



Discussion:

Departmental policy must support a long term, life – cycle approach to evaluating investment benefits and costs. UDOT must adopt a policy that clearly demonstrates to politicians that roads last longer than their term of office.

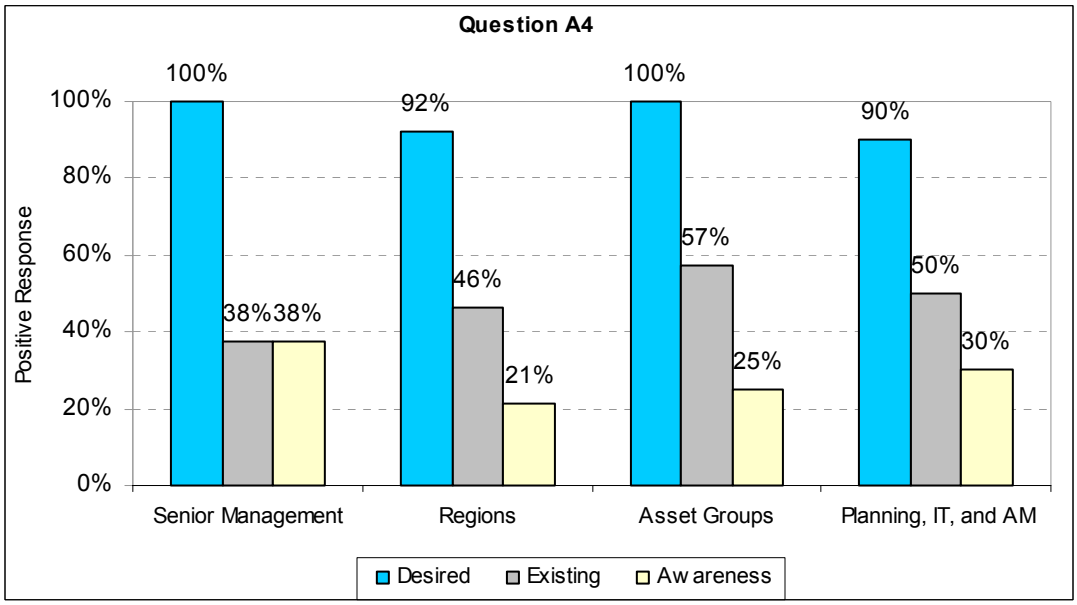
Initiatives to be developed in Asset Management Strategy:

- UDOT must formalize, approve and adopt an official Preservation Policy.
- UDOT must communicate this policy to all UDOT employees and stakeholders.

Timeline:	**Responsibility:**
Immediate	TRANSMAT

Policy Guidance benefiting from good Asset Management

Figure A4: Policy guidance considers customer perceptions and expectations



Discussion:

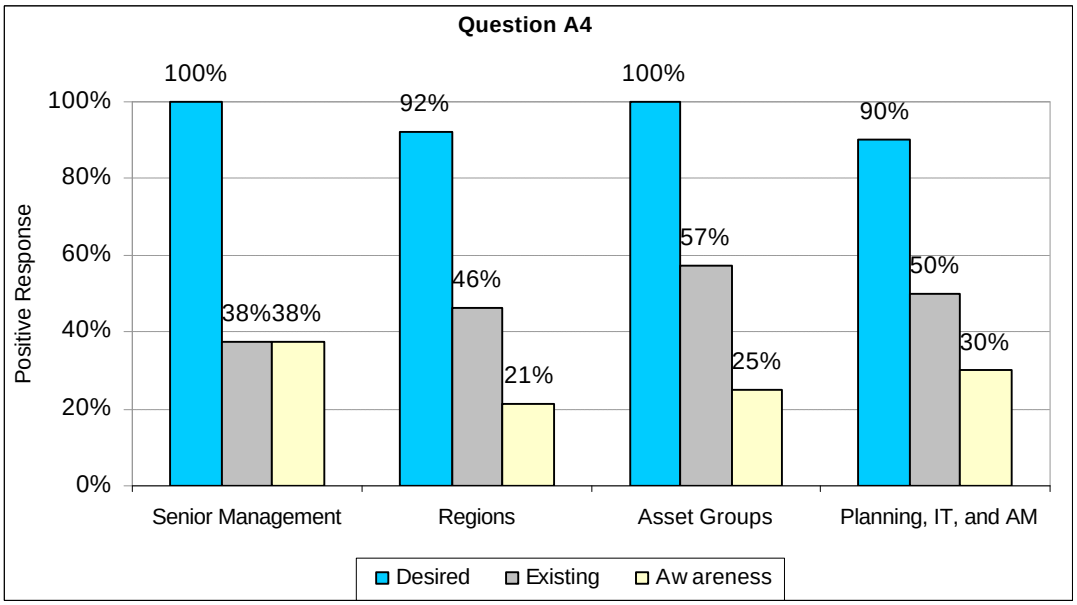
The UDOT mission clearly outlines the importance of customer satisfaction in its business and operations. UDOT must continue its efforts to engage its customers in dialogs that further the provision of transportation today and tomorrow within UTAH.

Initiatives to be developed in Asset Management Strategy:

- UDOT must formalize its processes and policies to gauge customer expectations and customer satisfaction.
- UDOT must continue to communicate this customer driven focus to all UDOT employees and stakeholders.

Timeline:	**Responsibility:**
Immediate	TRANSMAT

Figure A4: Policy guidance considers customer perceptions and expectations



Discussion:

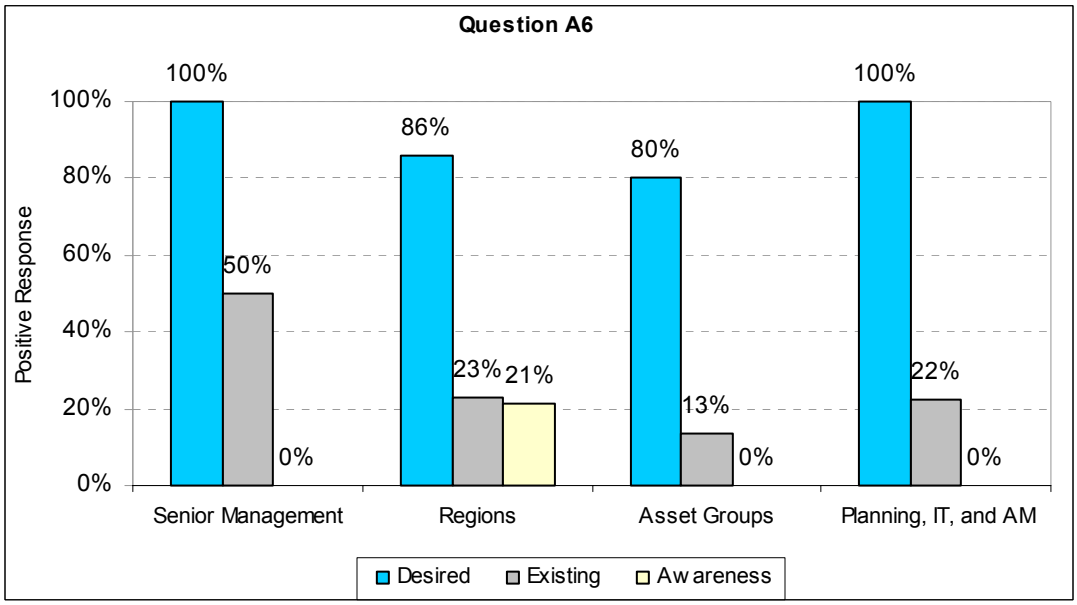
The UDOT mission clearly outlines the importance of customer satisfaction in its business and operations. UDOT must continue its efforts to engage its customers in dialogs that further the provision of transportation today and tomorrow within UTAH.

Initiatives to be developed in Asset Management Strategy:

- UDOT must formalize its processes and policies to gauge customer expectations and customer satisfaction.
- UDOT must continue to communicate this customer driven focus to all UDOT employees and stakeholders.

Timeline:	**Responsibility:**
Immediate	TRANSMAT

Figure A6: Policy guidance on resource allocation allows our agency sufficient flexibility to pursue a performance-based approach.



Discussion:

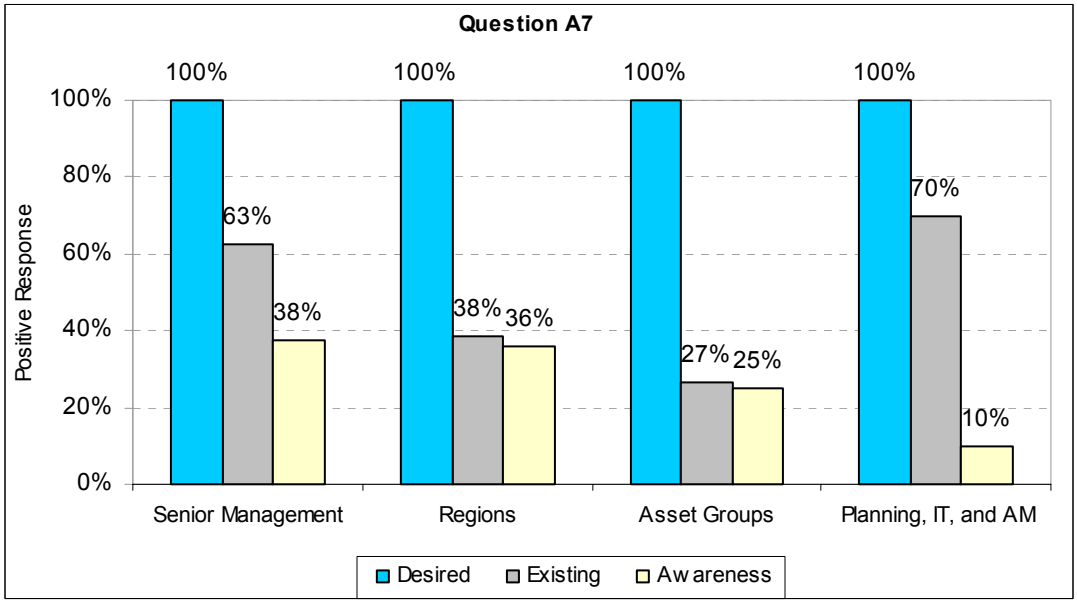
Resource allocation decisions must be linked to performance measures and objectives in conjunction with long range and short range planning.

Initiatives to be developed in Asset Management Strategy:

- Policies must favor resource allocation based on specific objectives and performance measures.
- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.

Timeline:	**Responsibility:**
Immediate	TRANSMAT (policy guidance)
One to Three Years	AM Team and Asset Groups

Figure A7: Our agency has a business plan or a strategic plan with comprehensive well-defined goals and objectives to guide resource allocation.



Discussion:

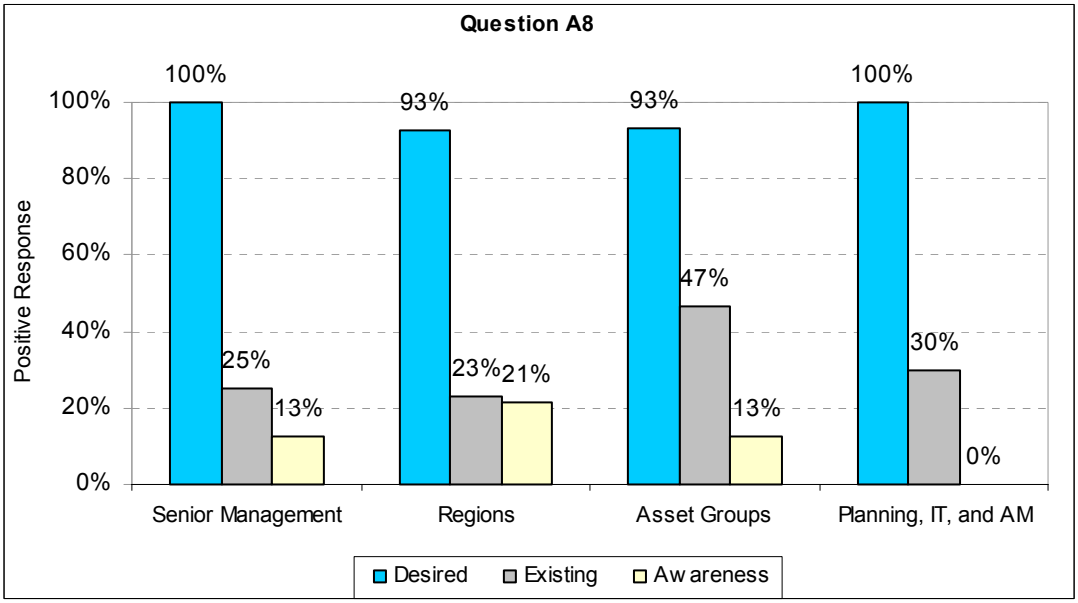
UDOT has recently invested a large amount of time and effort into its strategic planning to define what UDOT is as an organization and how it operates. The Final Four is a great step forward. In addition, UDOT's draft LRP helps explain the Final Four. However, UDOT needs to go further and place measurable goals and objectives within each of the four categories. Then UDOT will be able to measure and publicize progress.

Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.

Timeline:	**Responsibility:**
Immediate	TRANSMAT (policy guidance)
One to Three Years	AM Team and Asset Groups

Figure A8: Our agency's goals and objectives are linked to specific performance measures and evaluation criteria for resource allocation.



Discussion:

UDOT needs to develop measurable goals and objectives within each of the four categories in its strategic direction. Then UDOT will be able to measure and publicize progress towards those goals.

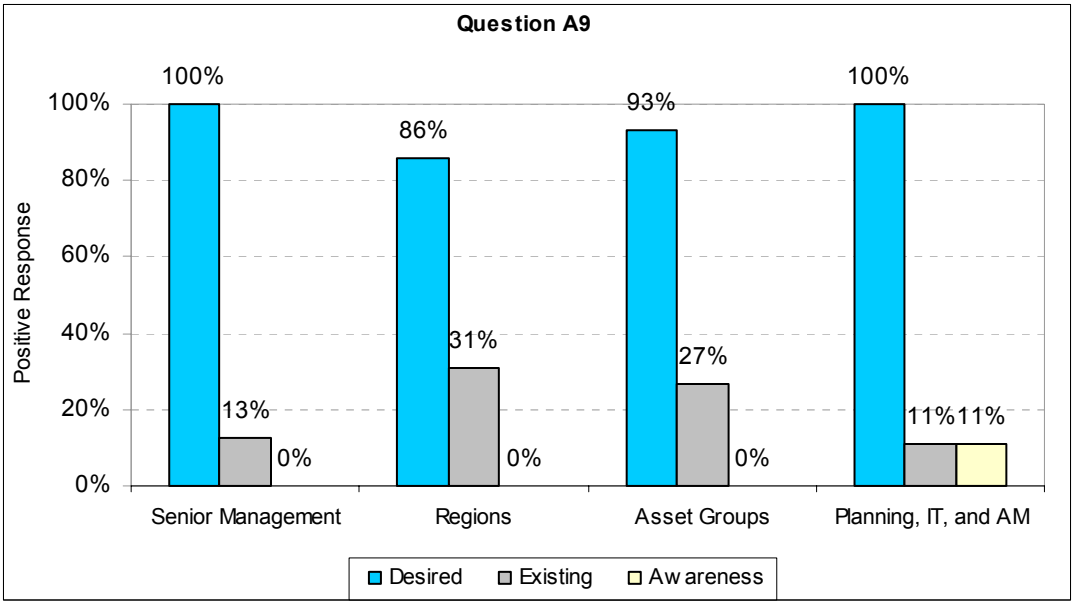
Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.

Timeline:	**Responsibility:**
Immediate	TRANSMAT (policy guidance)
One to Three Years	AM Team and Asset Groups

Proactive roles in policy formulation

Figure A9: Our agency estimates the resources needed to accomplish particular objectives as part of policy development.



Discussion:

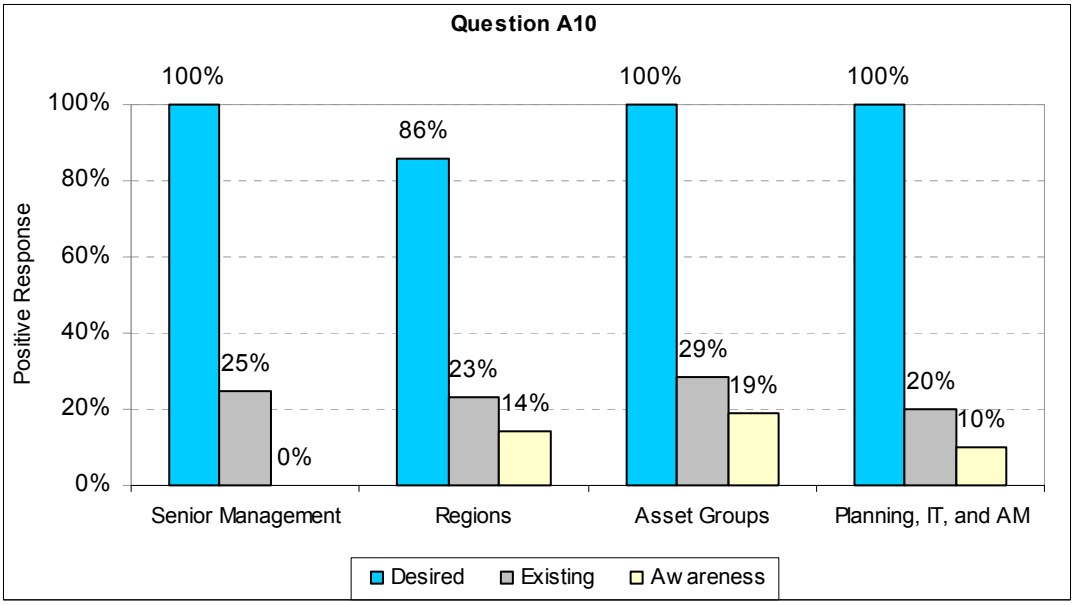
UDOT must take a more proactive approach to funding needs and actively estimate and publish funding needs as opposed to designing programs around existing funding allocations.

Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.
- Asset management and asset groups must consider funding needs required to meet the objectives contained within UDOT's strategic direction.

Timeline:	**Responsibility:**
Immediate	TRANSMAT (policy guidance)
One to Three Years	AM Team and Asset Groups

Figure A10: Our agency regularly communicates to customers and other stakeholders our accomplishments in meeting policy objectives.



Discussion:

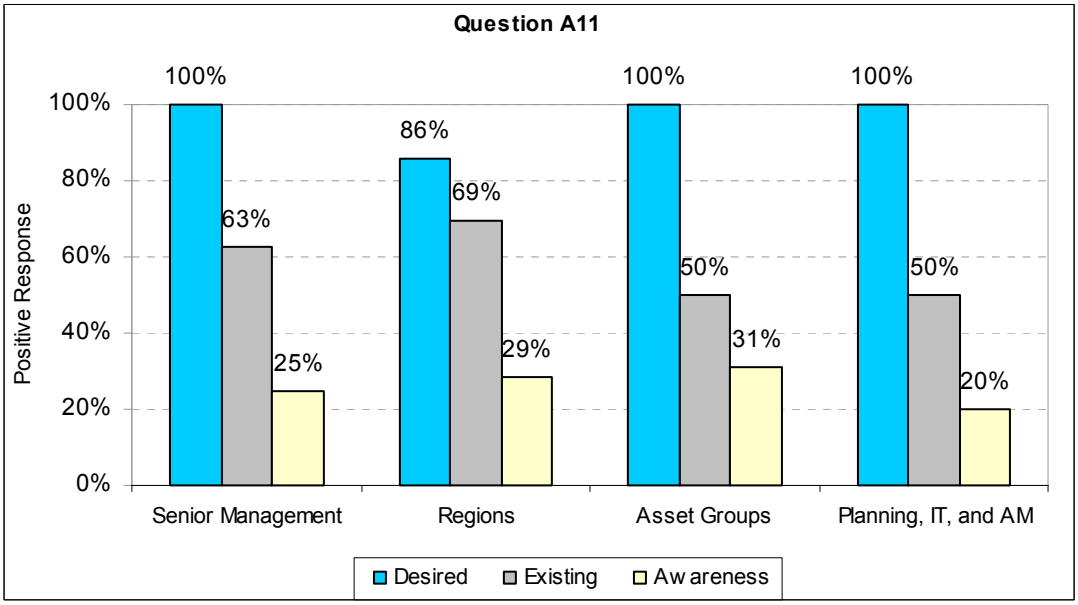
As UDOT develops performance measures for each of the goals within UDOT's strategic direction, these performance measures can be used to communicate funding needs, program delivery and accomplishments to UDOT stakeholders.

Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.
- UDOT must continue to develop methods to communicate its accomplishments to UDOT stakeholders.

Timeline:	**Responsibility:**
One to Three Years	TRANSMAT, AM Team and Asset Groups

Figure A11: Our agency works with political leaders and other stakeholders to present funding options and consequences as part of our budget proposals.



Discussion:

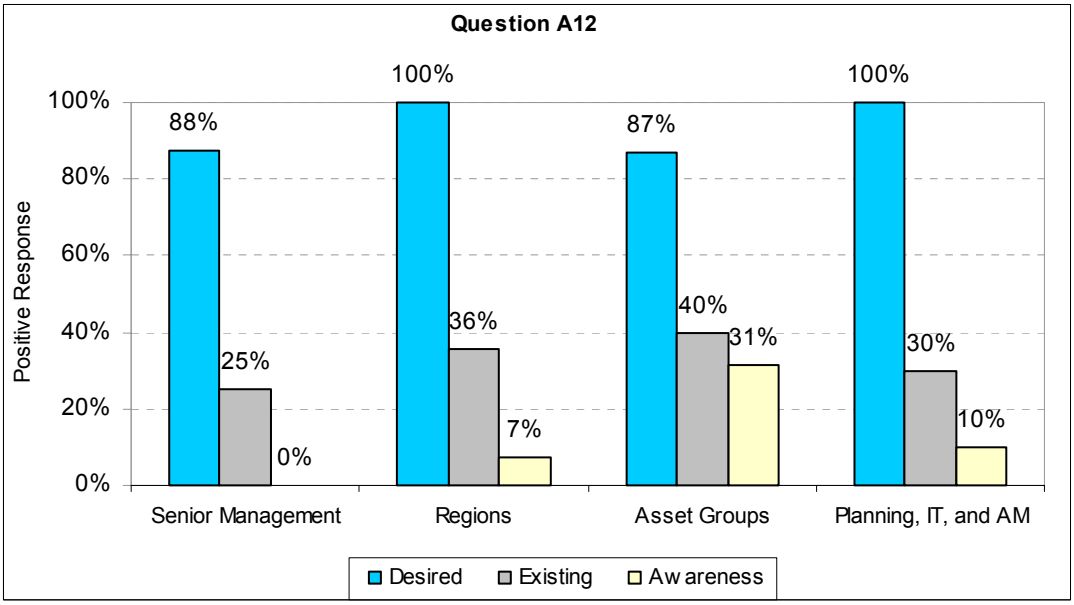
UDOT must work closely with political leaders to clearly indicate the consequences of funding shortfalls and the system performance that could result.

Initiatives to be developed in Asset Management Strategy:

- TRANSMAT must work closely with the Transportation Commission and clearly communicate funding needs and system performance.
- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.

Timeline:	**Responsibility:**
Immediate	TRANSMAT
One to Three Years	AM Team and Asset Groups

Figure A12: Policies are communicated in writing and are available for all employees and stakeholders to review at any time.



Discussion:

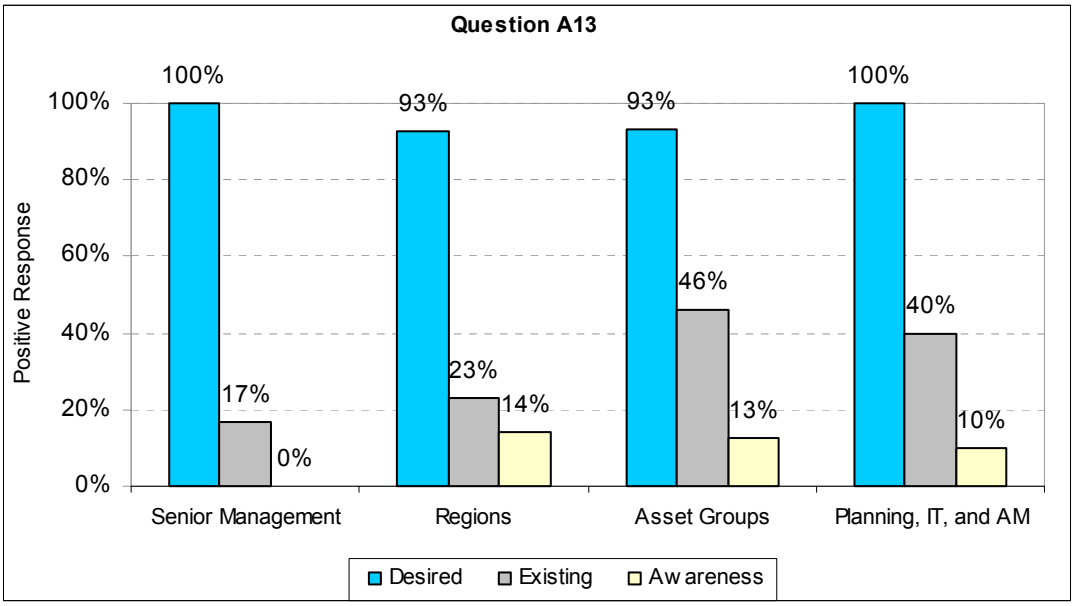
UDOT publishes its policy and procedure electronically on the Internet and the intranet. However, many policies and procedures need to be updated. Policy statements should give clear direction from a long-term perspective. This continuity is needed through changes in political or executive leadership or when critical decisions are being deliberated so that long-term objectives are not overlooked.

Initiatives to be developed in Asset Management Strategy:

- Policy guidance must encourage a formal approach to UDOT policies and procedures.

Timeline:	**Responsibility:**
Immediate	TRANSMAT
Two to Four Years	All

Figure A13: Policy clearly defines the characteristics of roadways that should be included in the state transportation network jurisdiction and those roadways that should be owned and maintain by other government agencies.



Discussion:

Ensuring that UDOT is maintaining assets consistent with a statewide transportation system will ensure that UDOT is maintaining the proper road network.

Initiatives to be developed in Asset Management Strategy:

- UDOT must formalize, approve and adopt an official policy outlining the characteristics of roadway assets that should be within UDOT's jurisdiction and those that should be owned and maintained by other government agencies.

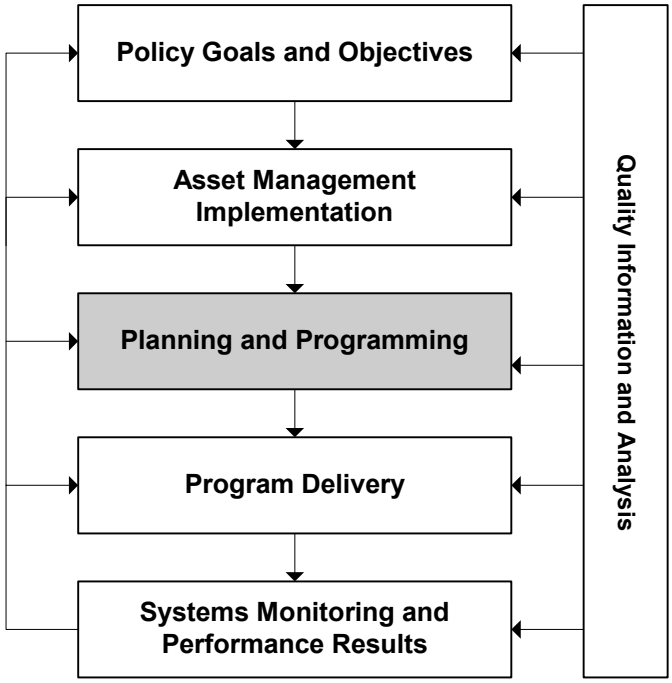
Timeline:	**Responsibility:**
Immediate	TRANSMAT, Program Development

4.B Planning and Programming

Overview: Long-range planning and priority programming should be central to UDOT's resource allocation decisions. It should provide long-range guidance to agency resource allocation that is consistent with policy objectives. It should identify and evaluate strategic investment choices and analyze tradeoffs between them, and it should have the information and analytic tools available to conduct the analysis implied by a performance-based process.

Program development is the stage of resource allocation that recommends specific investment actions whether for capital construction projects, preventative or corrective maintenance activities, or maintenance and operations services. Asset management speaks to several aspects of program development, and particularly to capital construction programming, which typically accounts for a large portion UDOT's budget and corresponds to the production of the STIP.

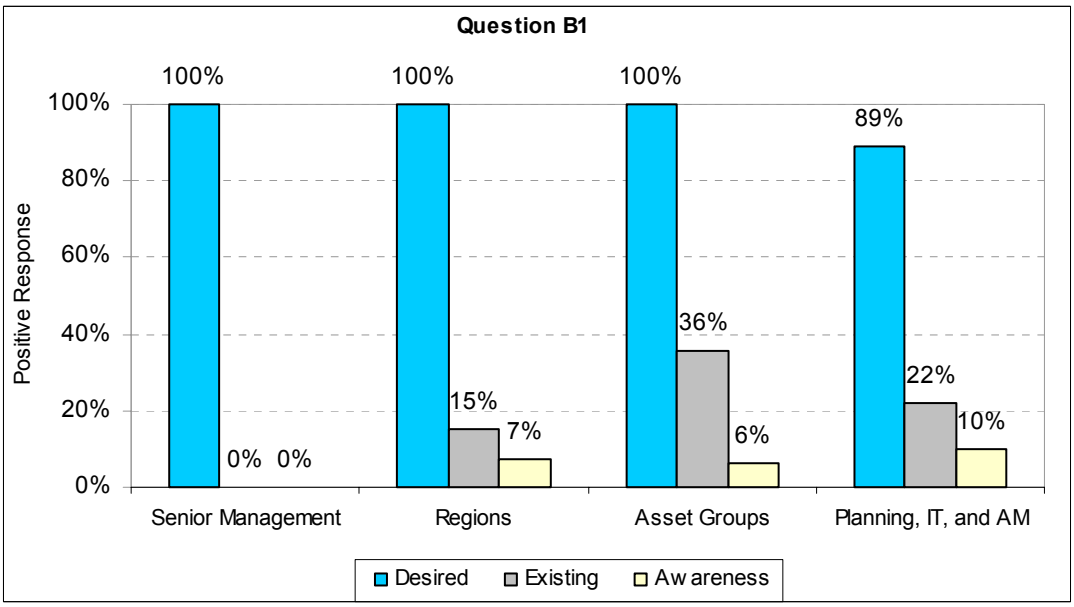
Figure B. Resource Allocation and Utilization – Planning and Programming



Asset Management Areas

- **Long-Range Planning**
- **Capital Programming Process**
- **Capital Program Structure and Definition**
- **Maintenance and Operations Programming**

Figure B1: Our agency's long-range plan includes an evaluation of capital, operational and modal alternatives to meet system deficiencies.



Discussion:

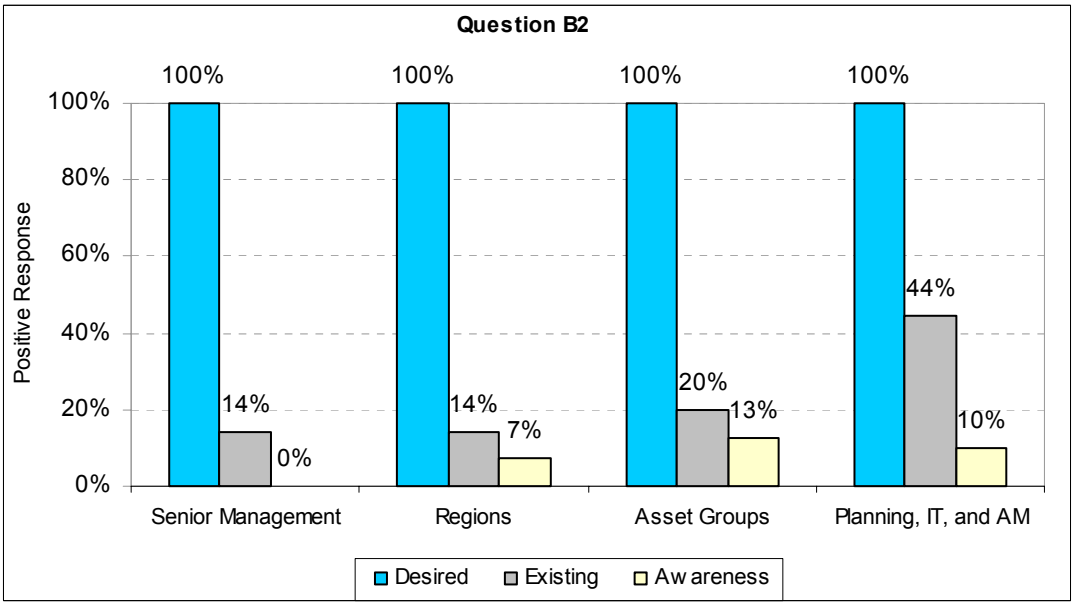
UDOT long-range strategic planning must consider and evaluate alternative strategies to meet system deficiencies.

Initiatives to be developed in Asset Management Strategy:

- Asset Management Team and Asset Groups must consider and evaluate alternative strategies to meet system deficiencies.
- Demand side planning alternatives must also be investigated and evaluated with supply side alternatives.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Planning

Figure B2: Capital versus maintenance expenditure tradeoffs is explicitly considered in the preservation of assets like pavements and bridges.



Discussion:

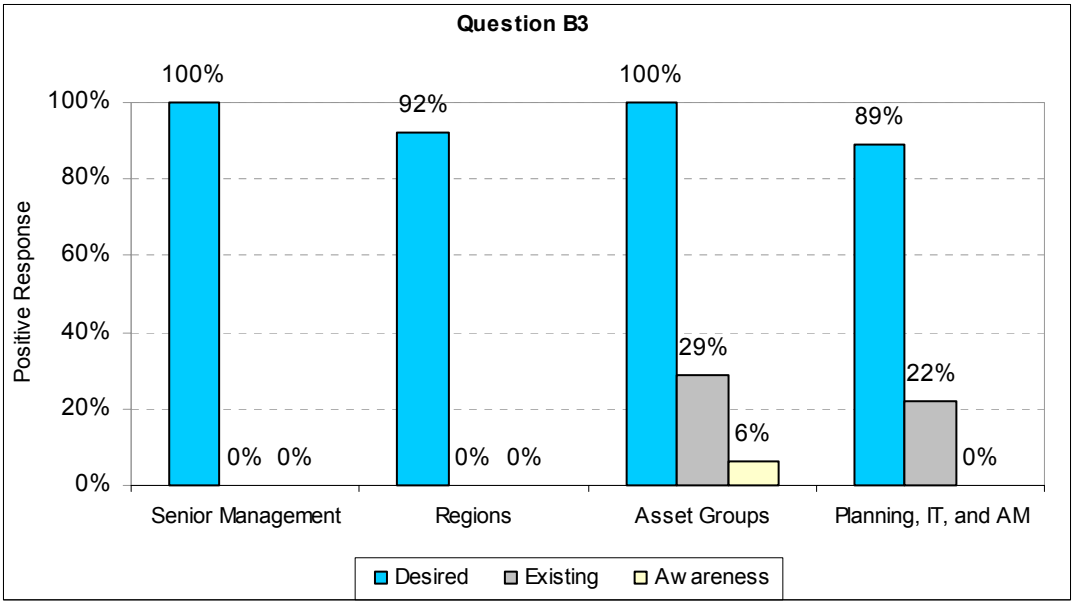
A successful life–cycle cost analysis resulting in an improvement program requires an effective mix of maintenance, rehabilitation and replacement strategies.

Initiatives to be developed in Asset Management Strategy:

- Improvement programs must consider a trade-off analysis between maintenance, rehabilitation and replacement strategies.

Timeline:	**Responsibility:**
Immediate	AM Team and Asset Groups

Figure B3: Capital versus operations tradeoffs is explicitly considered in seeking to improve traffic movement.



Discussion:

UDOT's Final Four recognizes the need for increased capacity but only after efforts have been made to improve the existing system's performance.

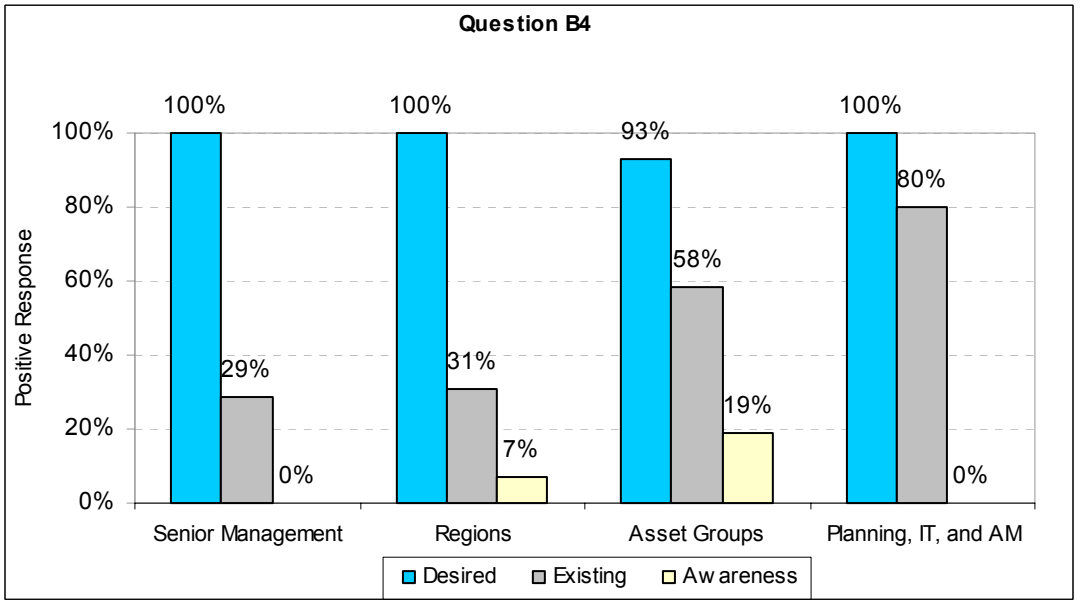
Initiatives to be developed in Asset Management Strategy:

- UDOT must develop mechanisms to consider capital expenditure versus operational improvements to improve traffic movement.

Timeline:	**Responsibility:**
Two to Four Years	Asset Groups

Performance based planning and clear linkage between policy, planning and programming

Figure B4: Our agency's long-range plan is consistent with currently established policy goals and objectives.



Discussion:

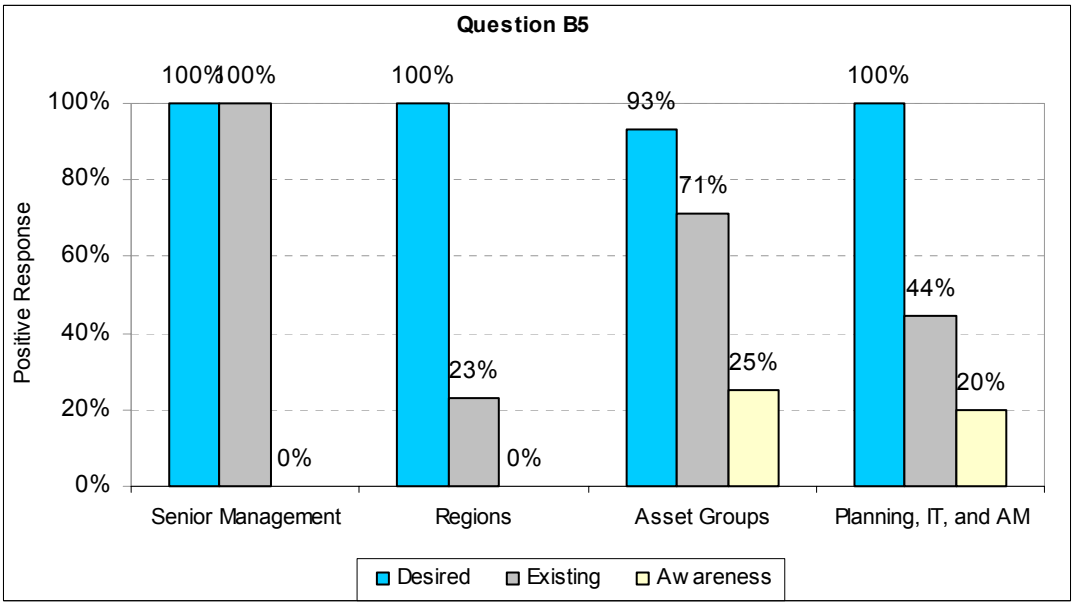
Long range planning must work in conjunction with UDOT's strategic direction, established goals, objectives and future performance measures.

Initiatives to be developed in Asset Management Strategy:

- Long range planning must work in conjunction with the policies and procedures established within the realm of good asset management practice.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Planning

Figure B5: Our agency's long-range plan includes strategies that are consistent with plausible projections of future revenues.



Discussion:

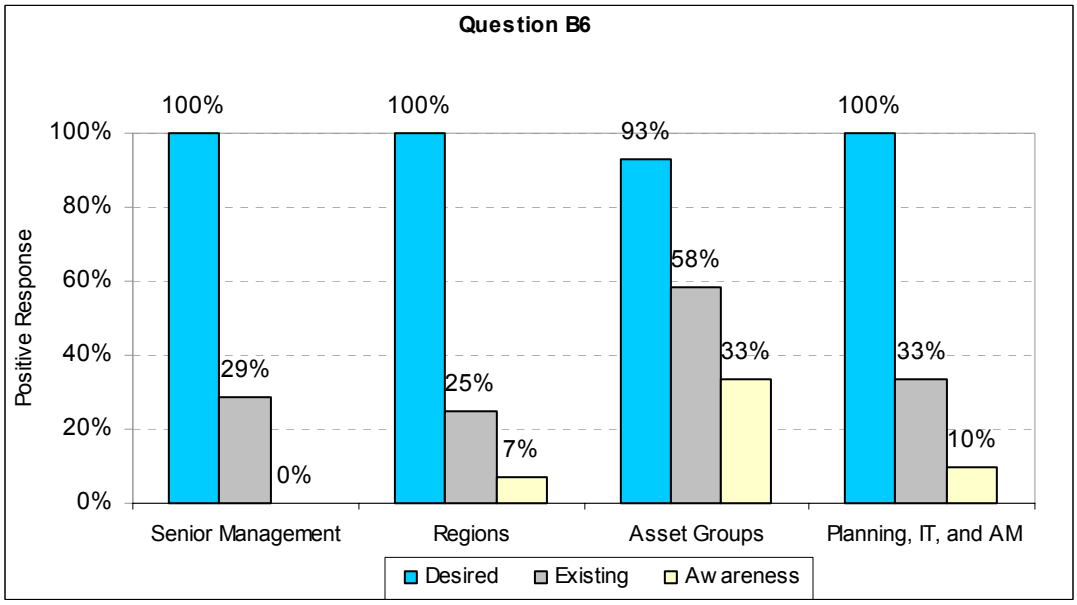
Long range planning must develop strategies in accordance with accurate projections of future revenue. There seems to be a variance in the existing implementation of this practice within UDOT as can be seen by the survey results.

Initiatives to be developed in Asset Management Strategy:

- Co-ordinate the development of plausible future revenue projections and distribute these projections throughout UDOT.

Timeline:	**Responsibility:**
Immediate	TRANSMAT and Program Development

Figure B6: Our agency's long-range plan provides clear and specific guidance for the capital program development process.



Discussion:

In UDOT, current long range planning is a separate process from tactical and operational level asset management. Planning, Asset Management and Asset Groups must work together to develop the long-range plan and the programs within each Asset Group.

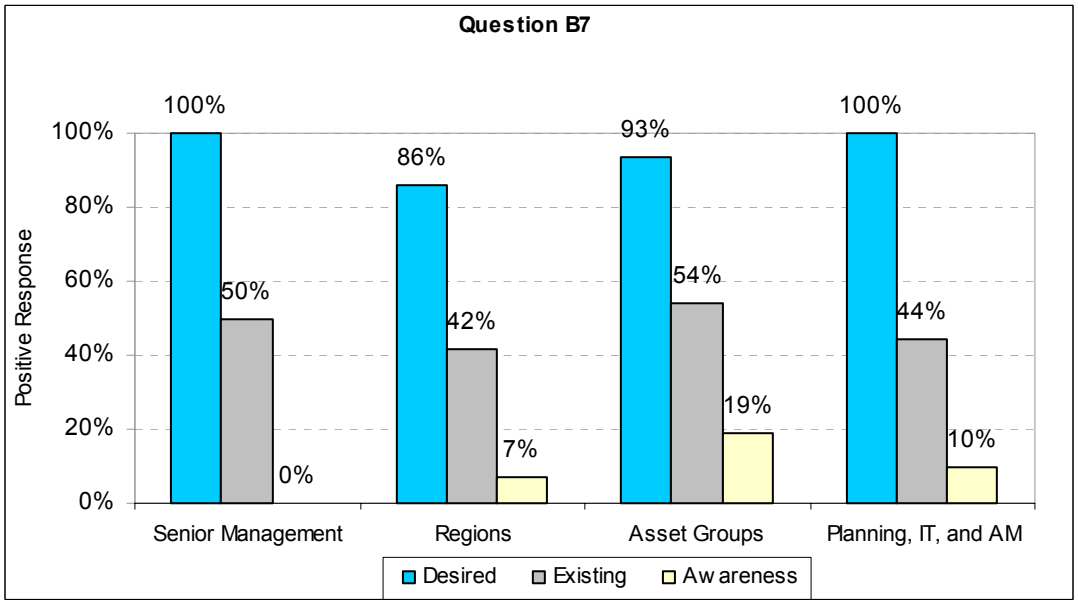
Initiatives to be developed in Asset Management Strategy:

- Coordinate the strategic, tactical and operational level planning and programming efforts in UDOT.

Timeline:	**Responsibility:**
Immediate	All

Performance based planning and clear linkage between policy, planning and programming

Figure B7: Our agency periodically updates its planning and programming methods to keep abreast of current policy guidance and critical performance criteria.



Discussion:

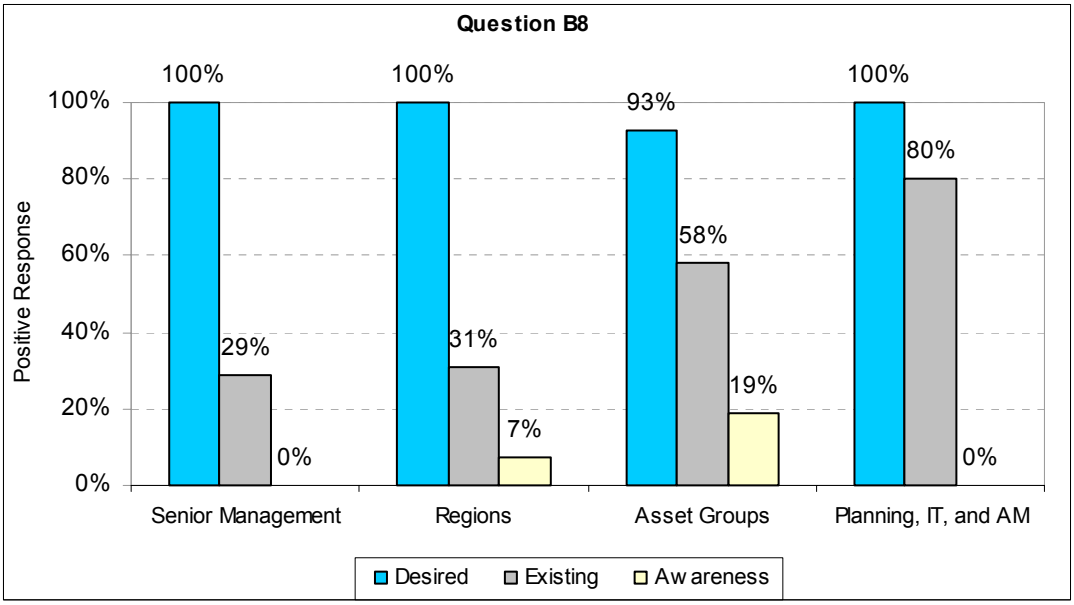
Tactical and Operational level asset management must keep informed of current policy and critical performance criteria and how this relates to strategic asset management and long range planning.

Initiatives to be developed in Asset Management Strategy:

- Coordinate the strategic, tactical and operational level planning and programming efforts in UDOT.

Timeline:	**Responsibility:**
Immediate	All

Figure B8: Criteria used to set program priorities, select projects and allocate resources are consistent with stated policy objectives and defined performance measures.



Discussion:

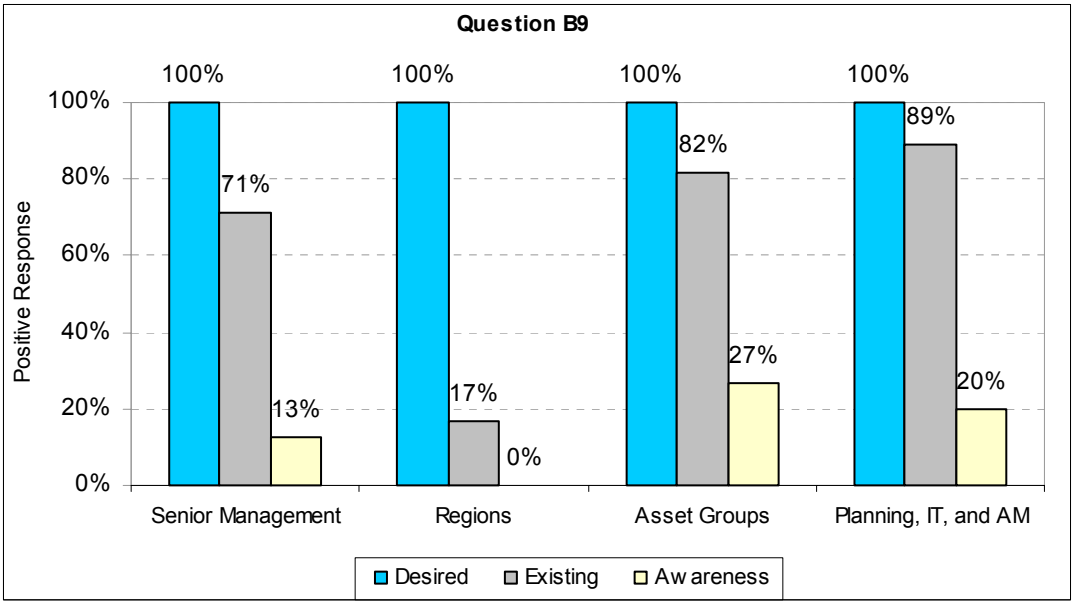
UDOT must clearly tie performance measures to its strategic goals and objectives and then use these measures at the strategic, tactical and operational levels in program planning and delivery.

Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.
- Coordinate the strategic, tactical and operational level planning and programming efforts in UDOT.

Timeline:	**Responsibility:**
Immediate	All
One to Three Years	AM Team and Asset Groups

Figure B9: Our agency's programs are consistent with realistic projections of future revenues.



Discussion:

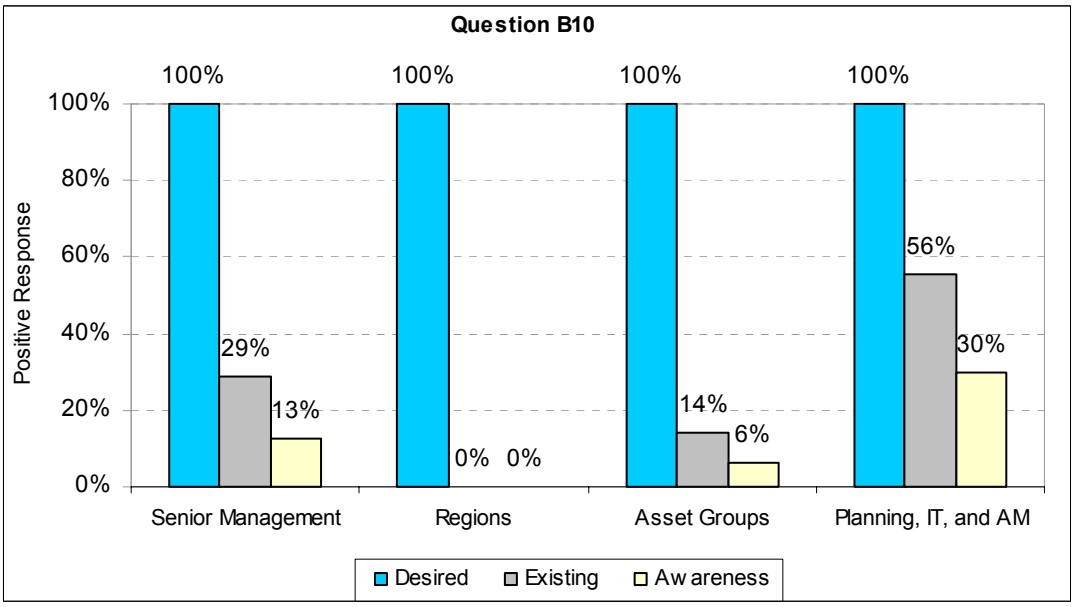
Strategic, tactical and operational planning and programming must develop strategies in accordance with accurate projections of future revenue.

Initiatives to be developed in Asset Management Strategy:

- Coordinate the development of plausible future revenue projections and distribute these projections throughout UDOT.

Timeline:	**Responsibility:**
Immediate	TRANSMAT and Program Development

Figure B10: Our agency's programs are based on realistic estimates of costs, benefits, and impacts on system performance.



Discussion:

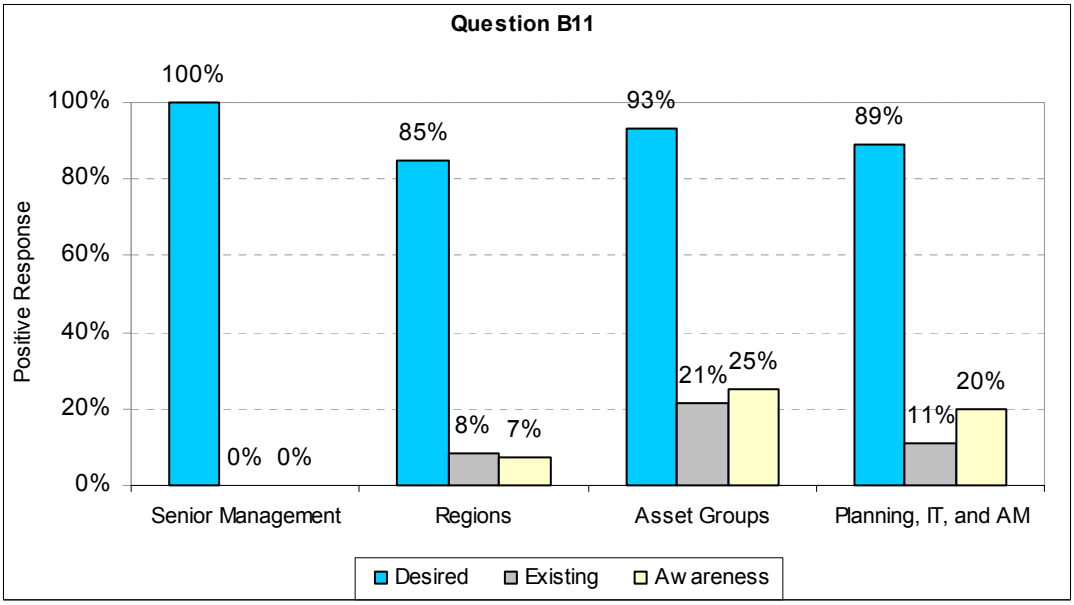
Program development at the strategic, tactical and operational levels must coordinate consistent and accurate model development to evaluate investment alternatives and alternative strategies for program development and delivery.

Initiatives to be developed in Asset Management Strategy:

- Coordinate the development of models that can be consistently and accurately used to model system performance and the impact of the various programs upon it.

Timeline:	**Responsibility:**
One to Three Years	All

Figure B11: Project selection is based primarily on an objective assessment of relative merits and the ability to meet performance targets.



Discussion:

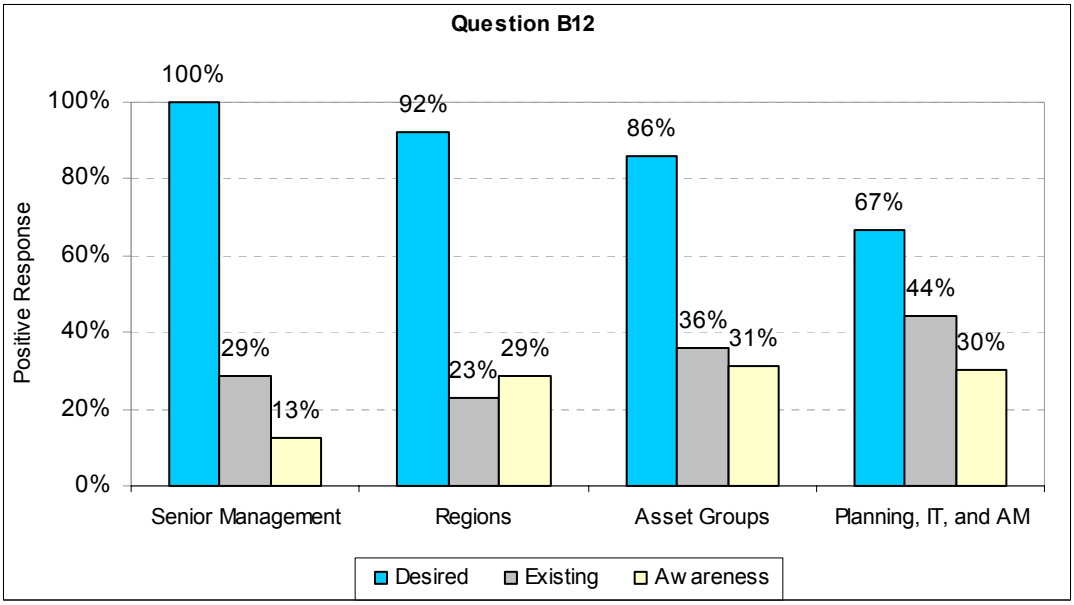
UDOT does not adequately tie its strategic direction to performance measures that can be used to set targets for each strategic goal and objective. Until measurable performance measures are developed for each strategic objective, project selection will not be based on meeting these objectives.

Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in resource allocation and project selection.

Timeline:	**Responsibility:**
One to Three Years	All

Figure B12: The preservation program budget is based upon analyses of at least life cycle costing rather than exclusive reliance on worst first strategies.



Discussion:

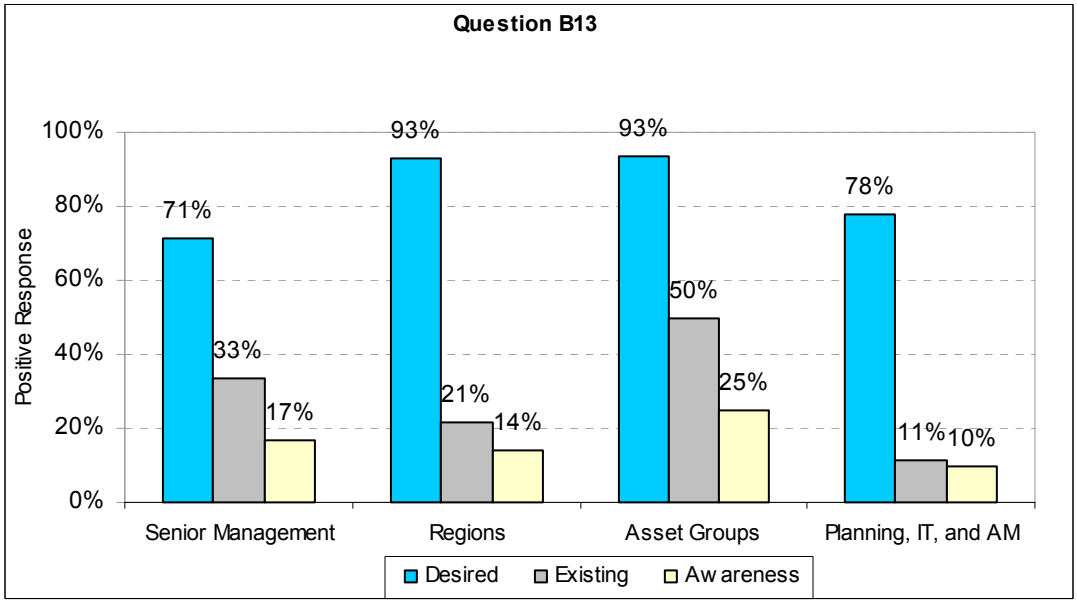
A life cycle cost analysis as a minimum must be used in preservation planning and program selection based upon meeting the strategic objectives of UDOT.

Initiatives to be developed in Asset Management Strategy:

- Coordinate the development and implementation of analysis tools that can benefit asset management analysis at all levels.

Timeline:	**Responsibility:**
One to Three Years	All

Figure B13: A maintenance quality assurance study has been implemented to define levels of service for highway and transportation system maintenance.



Discussion:

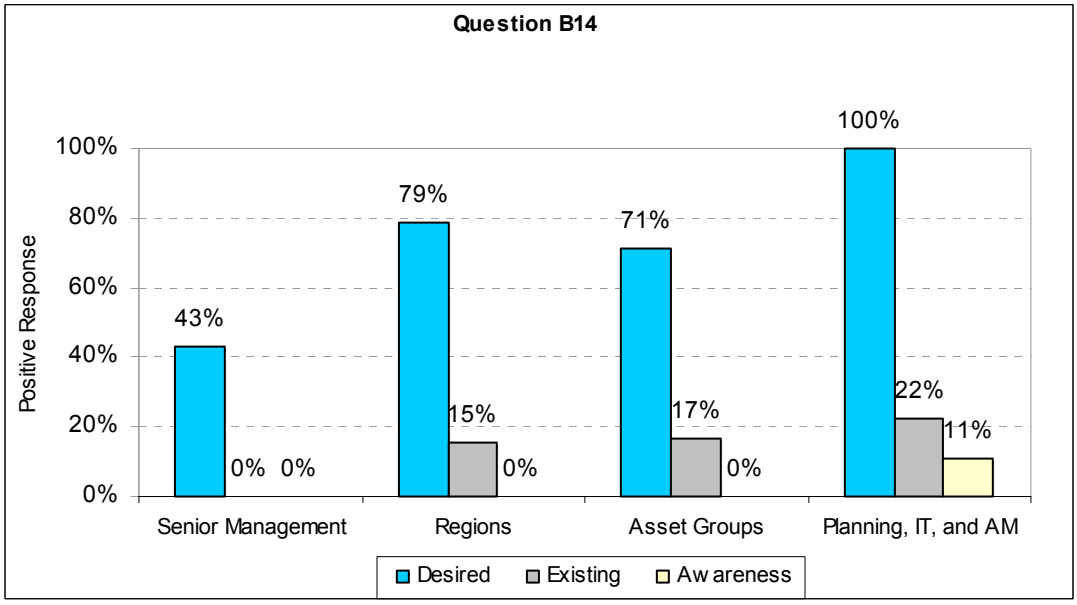
In order to effectively determine measurable goals and performance targets for short and long range planning, it is necessary to define appropriate levels of service for the UDOT network.

Initiatives to be developed in Asset Management Strategy:

- Levels of service must be developed to provide a measure against which service performance may be measured and projects selected.

Timeline:	**Responsibility:**
One to Three Years	All

Figure B14: Planning and Programming periodically audits the UDOT transportation network to ensure that the network includes only those assets as defined in official Policy regarding UDOT jurisdiction.



Discussion:

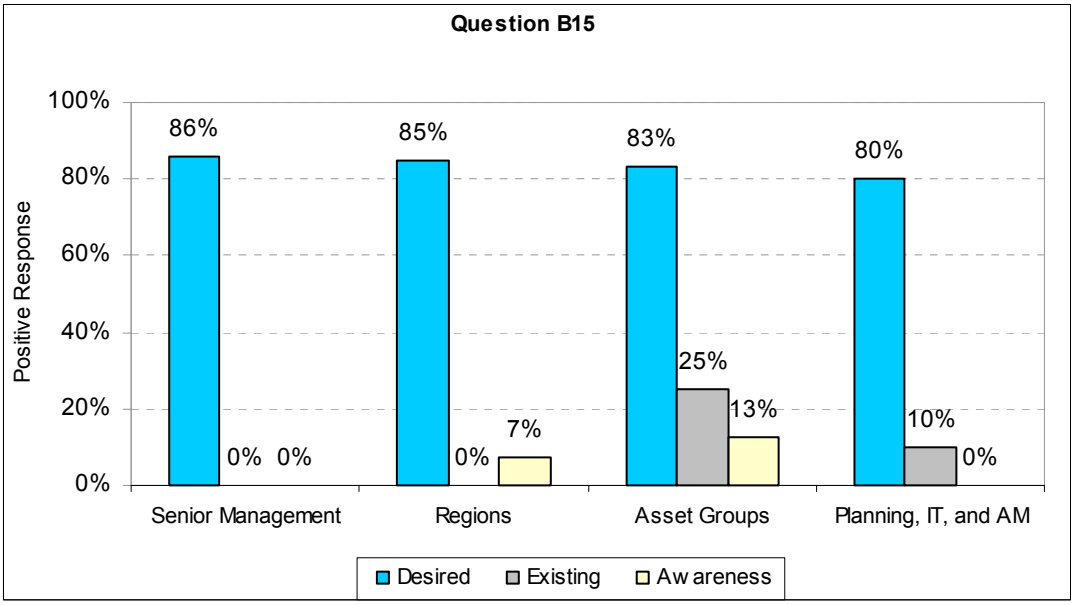
There is a great deal of variation in the responses to this survey question. In order to effectively implement good asset management practices it is important to ensure that the assets being managed are the appropriate ones.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend a procedure for auditing the UDOT transportation network to TRANSMAT for review.
- Research and recommend a method for periodically transferring assets to other jurisdictions where appropriate.

Timeline:	**Responsibility:**
Immediate	Program Development

Figure B15: Planning and Programming periodically transfer transportation network assets that do not meet the official Policy for UDOT jurisdiction.



Discussion:

As with survey question B14, in order to effectively implement good asset management practices it is important to ensure that the assets being managed are the appropriate ones.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend a procedure for auditing the UDOT transportation network to TRANSMAT for review.
- Research and recommend a method for periodically transferring assets to other jurisdictions where appropriate.

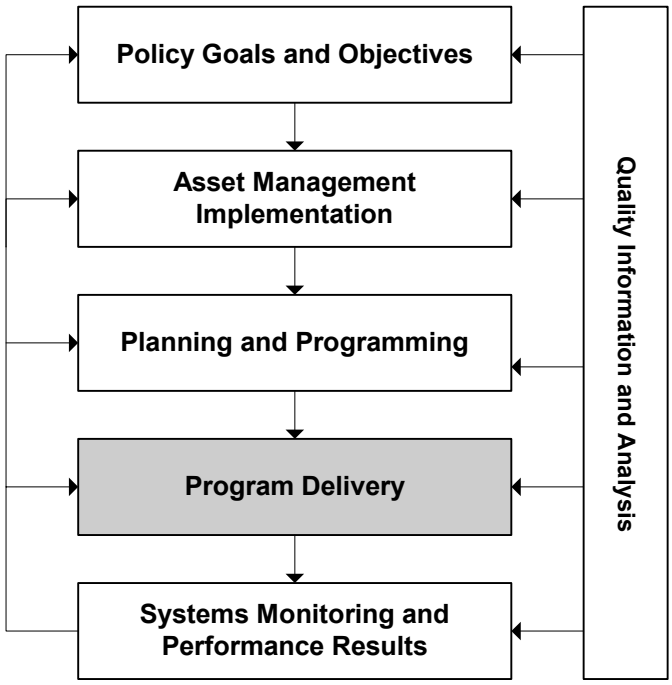
Timeline:	**Responsibility:**
One to three years	Program Development

4.C Program Delivery

Overview: Resource allocation decisions result in a recommended transportation improvement program. Program delivery puts this program "on the ground" through decisions in resource allocation to determine how program work will be accomplished. Key challenges for program delivery include maximizing efficiency and effectiveness of agency resources, meeting customer expectations, minimizing adverse customer impacts, adhering to project scope, schedule and budget, and managing needed changes in projects and programs.

Three Asset Management principles apply to program delivery, which are: Investigating a range of delivery options, better program management, and better cost tracking.

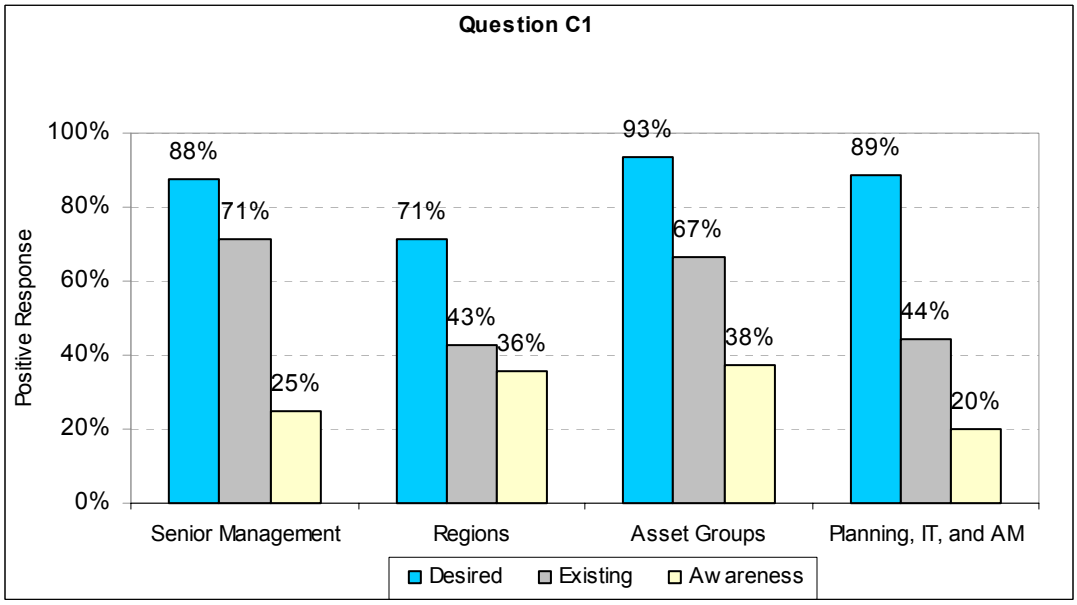
Figure C. Resource Allocation and Utilization – Program Delivery



Asset Management Areas

- **Alternative Delivery Methods**
- **Program Management**
- **Cost Tracking**

Figure C1: Our agency periodically evaluates the use of alternative delivery options such as maintenance outsourcing, intergovernmental agreements, design- build - maintain and similar options.



Discussion:

Alternatives for program delivery may help to manage the UDOT transportation network more efficiently. UDOT must continue to investigate and use alternative delivery options where appropriate.

Initiatives to be developed in Asset Management Strategy:

- Keep abreast of new technologies and approaches to program delivery and coordinate the implementation of these approaches.

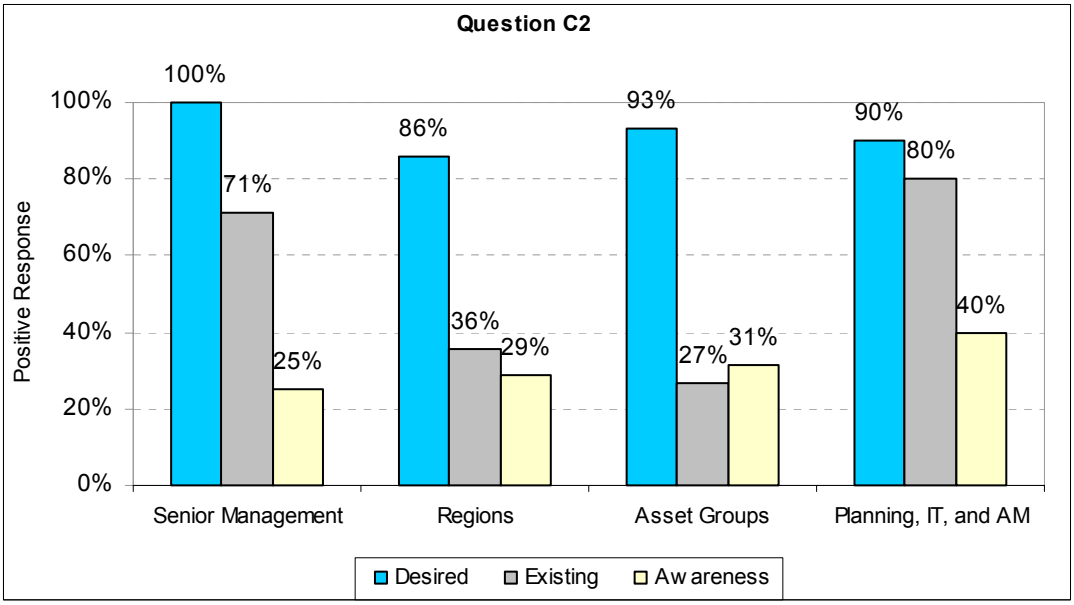
Timeline:

One to Three Years

Responsibility:

Project Development and Regions

Figure C2: Our agency has an incentive program for recognizing or rewarding outstanding performance in improving upon schedule, quality, and cost objectives.



Discussion:

Incentive programs and alternative program delivery options may provide innovative solutions to manage the UDOT transportation network more efficiently.

Initiatives to be developed in Asset Management Strategy:

- Keep abreast of new approaches to program delivery and coordinate the implementation of these approaches.

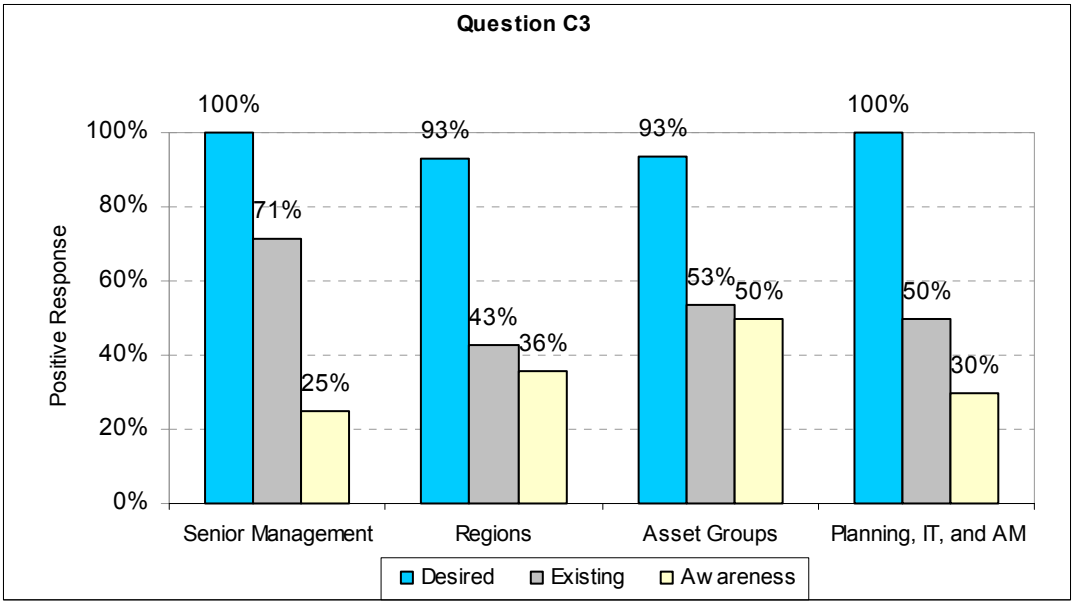
Timeline:

One to Three Years

Responsibility:

Project Development and Regions

Figure C3: Our agency solicits input from all affected parties to ensure that project scope is consistent with objectives of the project.



Discussion:

Changes in cost, scope, schedule and quality can greatly affect the final delivered project. Any changes to the project must be reviewed to ensure the project is consistent with the original objectives.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project consistency from the project conception phase through to completion.

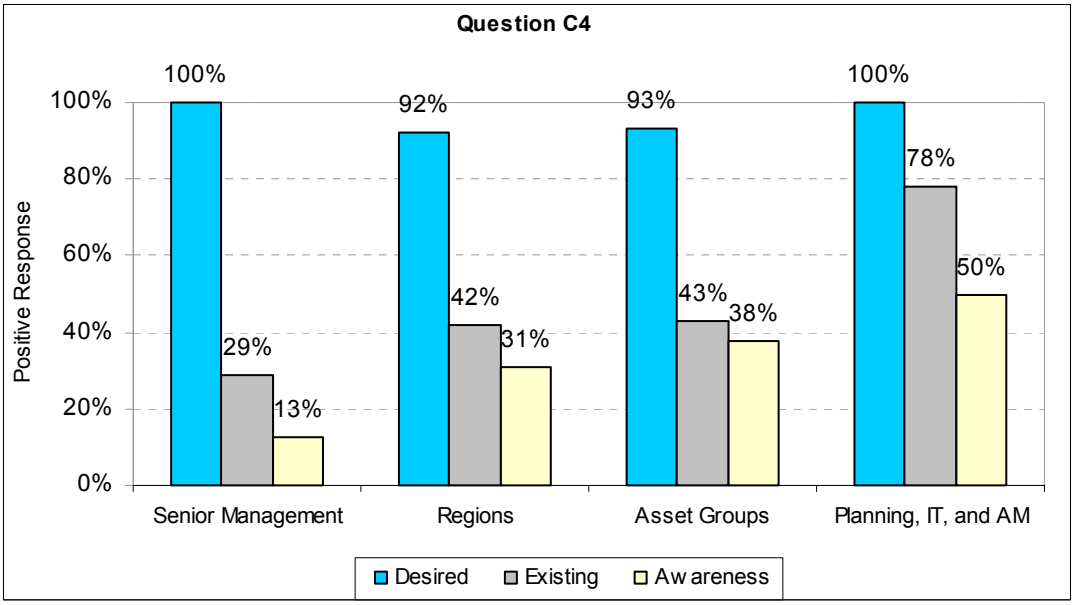
Timeline:

One to Three Years

Responsibility:

Program Development and Project Development

Figure C4: Our agency uses well defined program delivery measures to track adherence to project scope, schedule and budget.



Discussion:

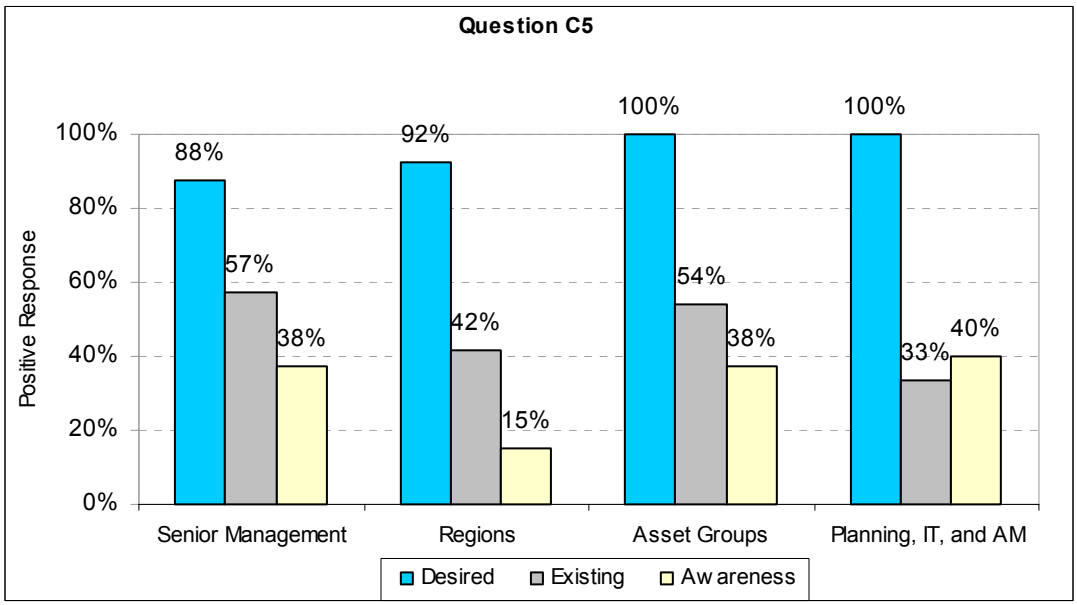
Changes in cost, scope, schedule and quality can greatly affect the final delivered project. Any changes to the project must be reviewed to ensure the project is consistent with the original objectives.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project consistency from the project conception phase through to completion.

Timeline:	**Responsibility:**
One to Three Years	Program Development and Project Development

Figure C5: Our agency has a well-established and functioning process to approve project changes and program adjustments.



Discussion:

Changes in cost, scope, schedule and quality can greatly affect the final delivered project. Any changes to the project must be reviewed to ensure the project is consistent with the original objectives.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project consistency from the project conception phase through to completion.

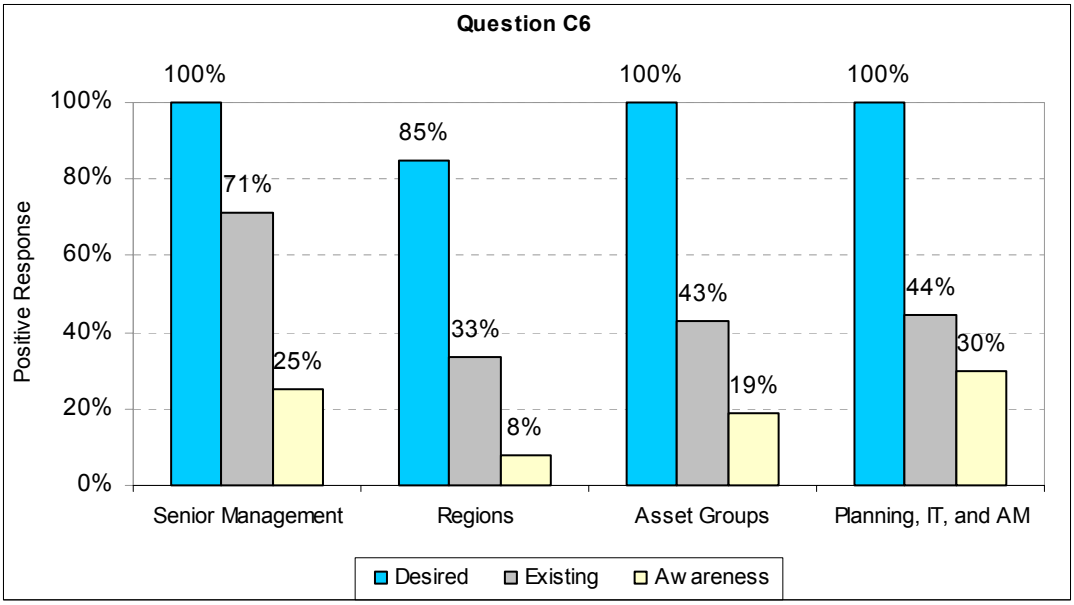
Timeline:

One to Three Years

Responsibility:

Program Development and Project Development

Figure C6: When adding projects or changing project schedules, our agency considers the effects on the delivery of other projects in the program.



Discussion:

Changes in cost, scope, schedule and quality can greatly affect the final delivered project. Any changes to the project must be reviewed to ensure the project is consistent with the original objectives.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure consistency from the conception phase through to project completion.

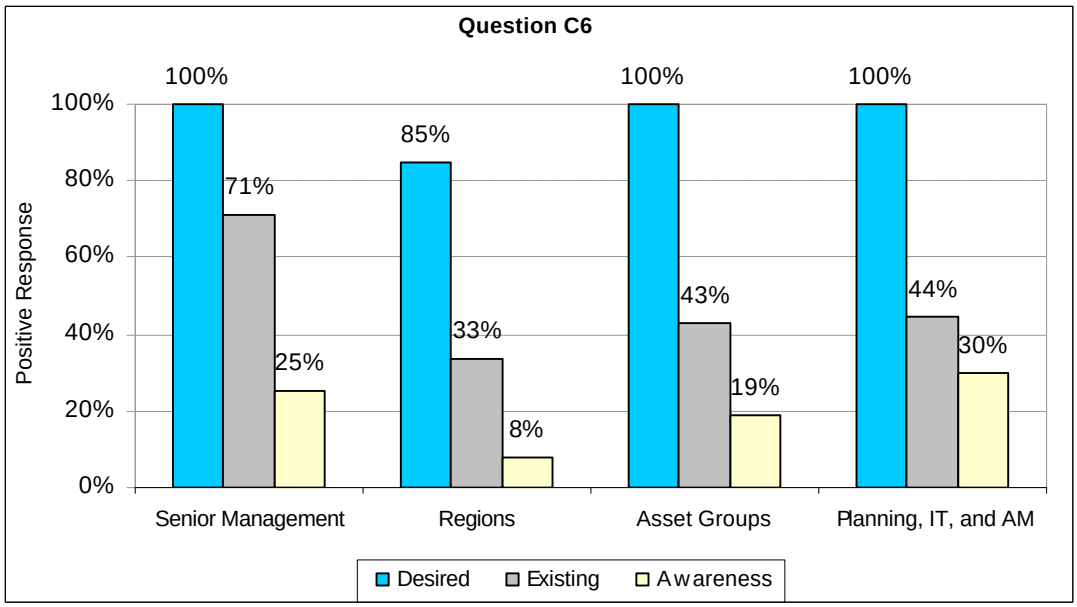
Timeline:

One to Three Years

Responsibility:

Program Development, Project Development

Figure C6: When adding projects or changing project schedules, our agency considers the effects on the delivery of other projects in the program.



Discussion:

Changes in cost, scope, schedule and quality can greatly affect the final delivered project. Any changes to the project must be reviewed to ensure the project is consistent with the original objectives.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure consistency from the conception phase through to project completion.

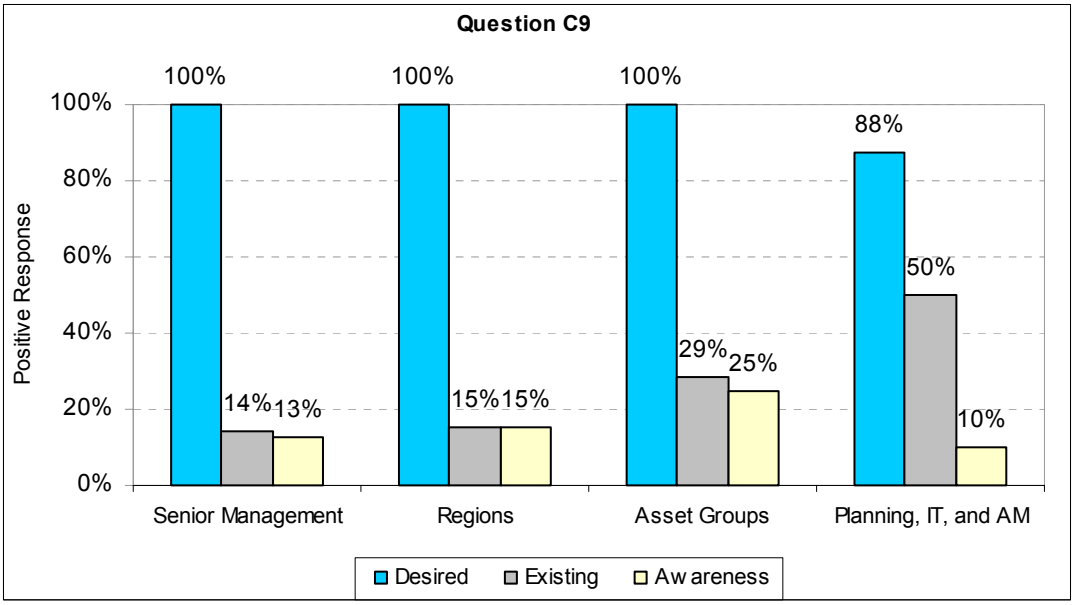
Timeline:

One to Three Years

Responsibility:

Program Development, Project Development

Figure C8: Agency executives and program managers are regularly kept informed of program delivery status.



Discussion:

Communicating program delivery performance measures to agency executives may help pinpoint focus areas within the department that need to be evaluated.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project consistency from the project conception phase through to completion.
- Ensure that the project tracking system reports are readily available to agency executives and program managers.

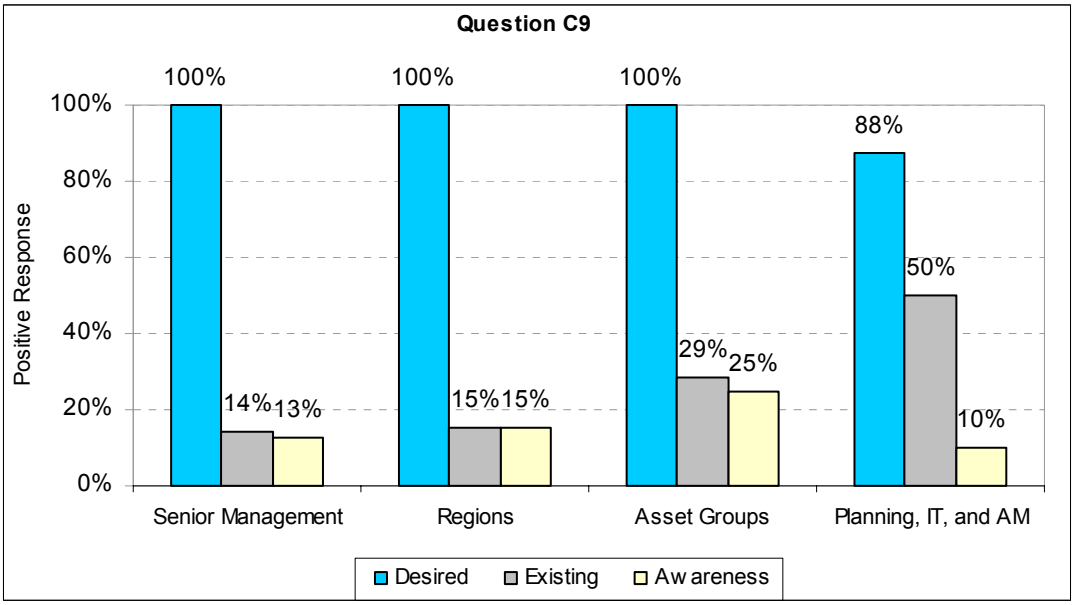
Timeline:

One to Three Years

Responsibility:

Program Development and Project Development

Figure C9: External stakeholders and policy-makers feel that they are sufficiently updated on program delivery status.



Discussion:

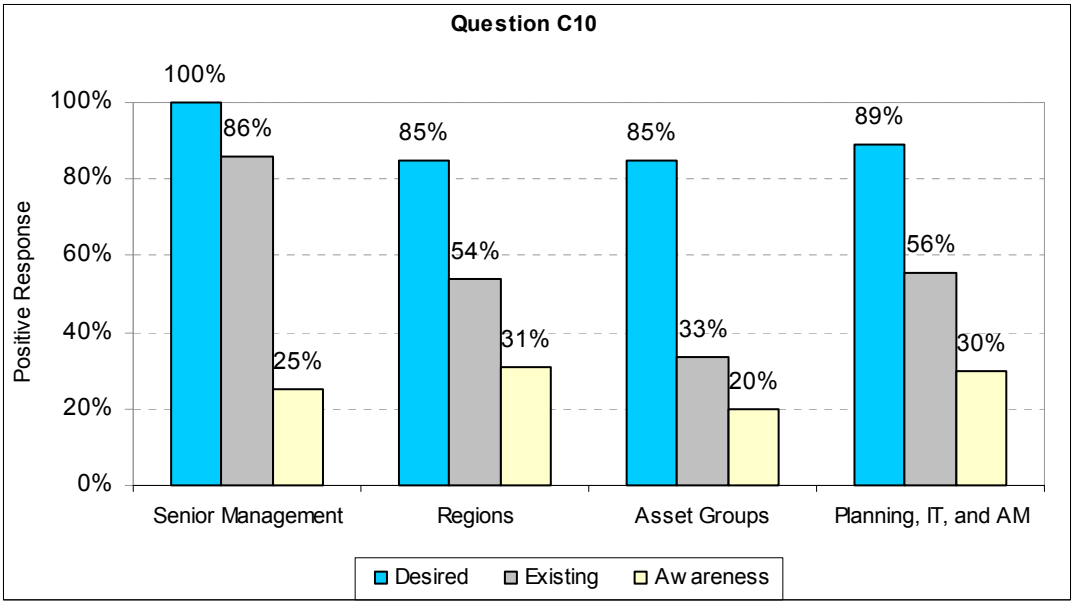
Keeping external stakeholders and policy makers updated and informed on program delivery status helps to strengthen credibility and accountability with external stakeholders.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project consistency from the project conception phase through to completion.
- Ensure that the project tracking system reports are available to external stakeholders and policy makers.

Timeline:	**Responsibility:**
One to Three Years	Program Development and Project Development

Figure C10: Our agency maintains and uses information on the full unit costs of construction activities.



Discussion:

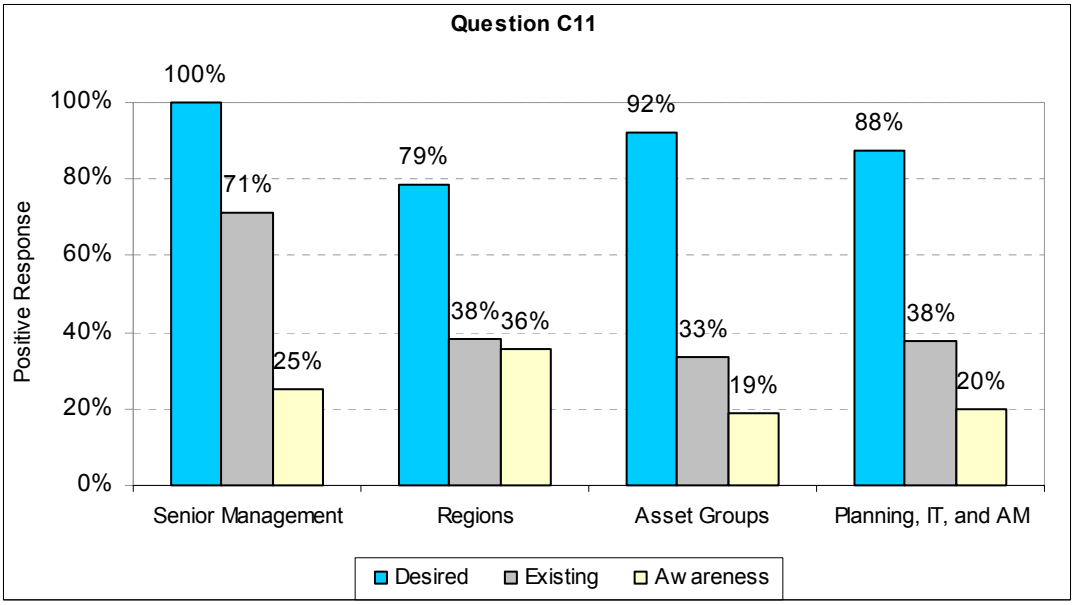
Accurate and reliable unit cost data is important for future project estimates and for current program delivery. If costing data is unreliable the results of strategic level asset management and planning and programming at the tactical and operational levels and can be disastrous.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project-costing information is accurate and reliable.
- Ensure that updated project cost information is available for any cost projections within the department.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Project Development

Figure C11: Our agency maintains and uses information on the full unit costs of maintenance activities.



Discussion:

Accurate and reliable unit cost data is important for future project estimates and for current program delivery. If costing data is unreliable the results of strategic level asset management and planning and programming at the tactical and operational levels and can be disastrous.

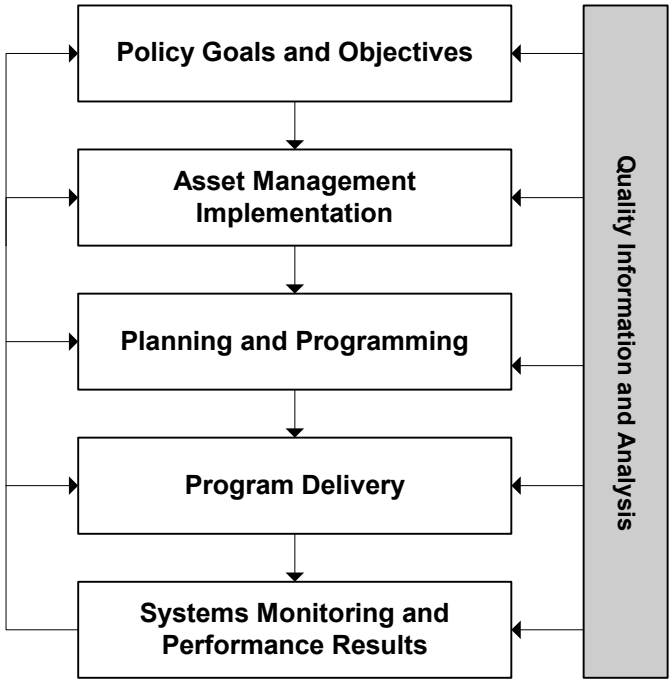
Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project-costing information is accurate and reliable.
- Ensure that project cost information contains details on the full unit costs including both direct and indirect costs.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Operations

Overview: A sound asset management approach requires objective, high-quality data, presented to decision-makers and other stakeholders as understandable, useful information. It is a systems analysis challenge to catalog the many stakeholders and their information requirements, find the simplest analytical and presentation methods that meet as many stakeholder needs as possible, and design data collection processes that efficiently meet the analyses with an acceptable level of quality. In this context, information technology (IT) is a tool to support asset management, not an end in itself.

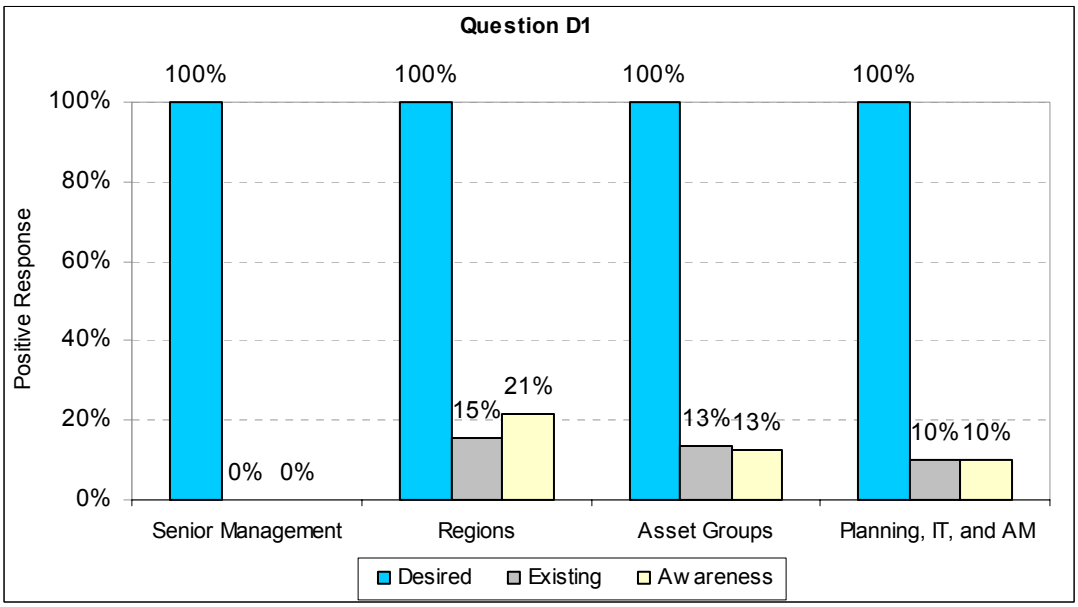
Figure D. Resource Allocation and Utilization – Quality Information and Analysis



Asset Management Areas

- **Information Needs and Data Quality**
- **Data Integration and Accessibility**
- **Decision Support**
- **System Monitoring and Feedback**
- **Reporting and Documentation**

Figure D1: Our agency has a complete and up-to- date inventory of our major assets.



Discussion:

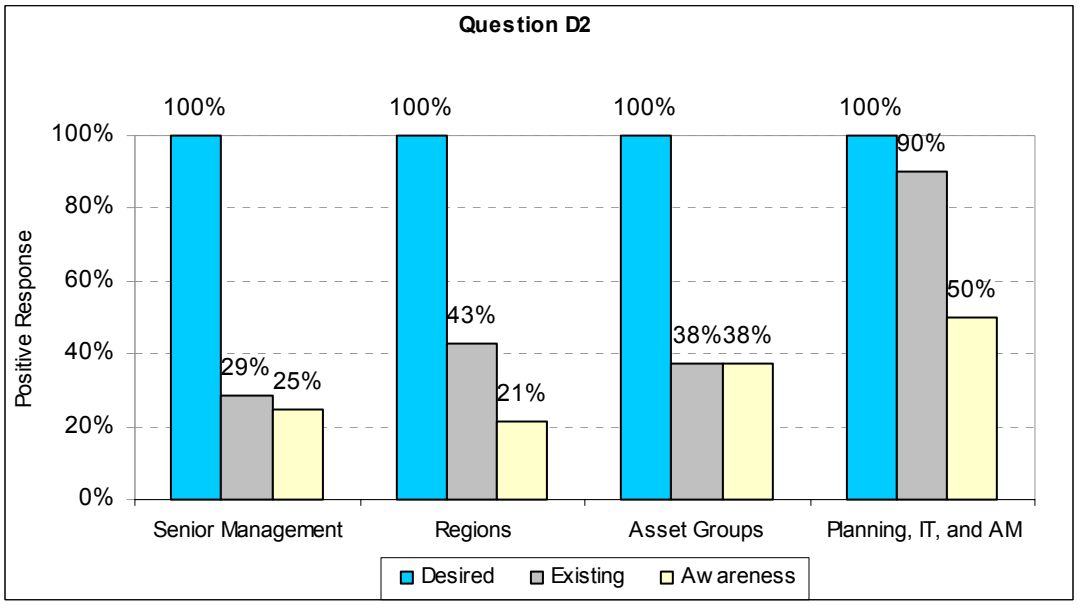
Recognizing the need for an up-to-date and accurate asset inventory including classification, condition, performance and use data (where appropriate) is an important first step towards developing an asset management system.

Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level.
- Continued implementation of asset specific systems at the tactical and operational level.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Regions

Figure D2: Our agency regularly collects data on the condition of our assets



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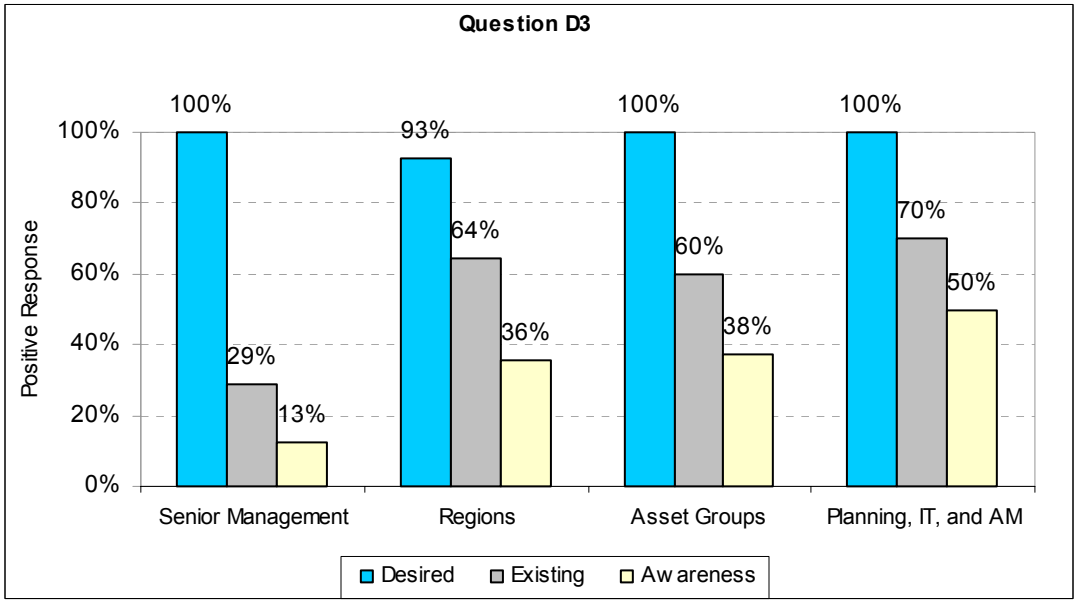
Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level.
- Continued implementation of asset specific systems at the tactical and operational level.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Regions

Figure D3: Our agency regularly collects data on the performance of our assets such as (serviceability, ride quality, capacity, operations, and safety improvements).



Discussion:

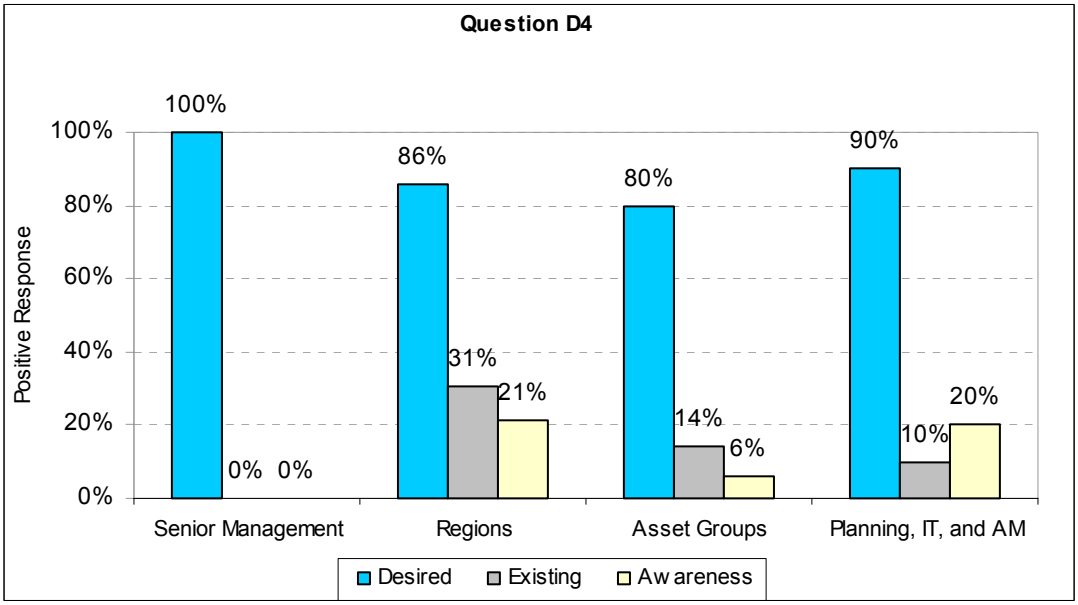
Recognizing the need for an up-to-date and accurate asset inventory including classification, condition, performance and use data (where appropriate) is an important first step towards developing an asset management system.

Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT and asset specific systems throughout the department.
- Formalize a data collection policy that assists in determining what level of data collection is necessary for each asset being managed.

Timeline:	**Responsibility:**
Immediate	TRANSMAT, AM Team, Asset Groups and Regions

Figure D4: Our agency regularly collects customer perceptions of asset condition and performance.



Discussion:

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Initiatives to be developed in Asset Management Strategy:

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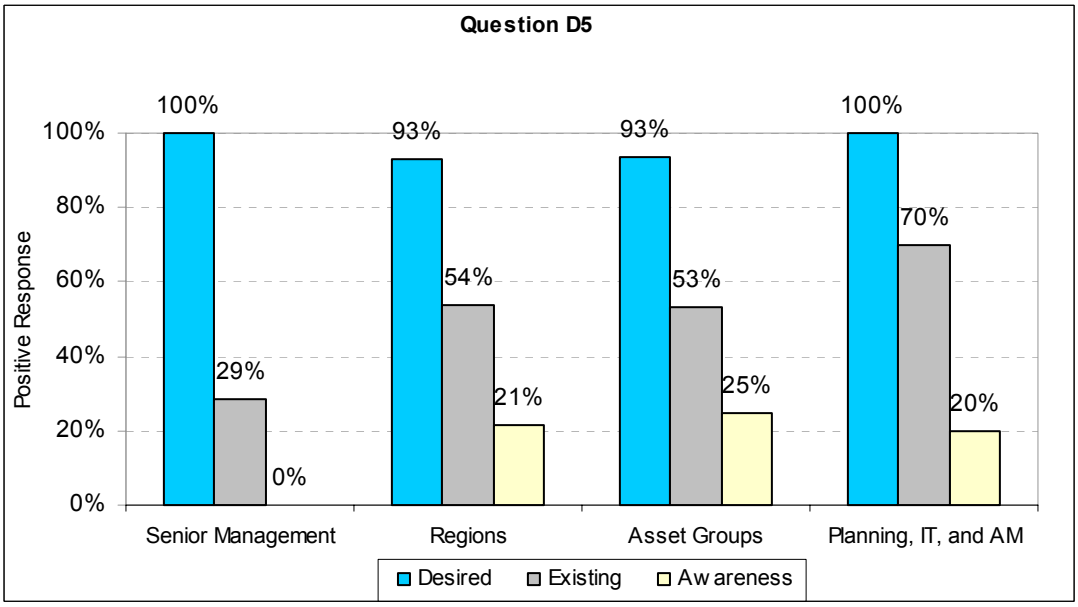
- Formalize a data collection policy that assists in determining what level of data collection is necessary for each asset being managed.

Timeline:	**Responsibility:**
Immediate	TRANSMAT, AM Team, Asset Groups and Regions

Figure D5: Our agency continually seeks to improve the efficiency of data collection (e.g. through sampling techniques, automated equipment, and other methods appropriate to our transportation service.



Discussion:

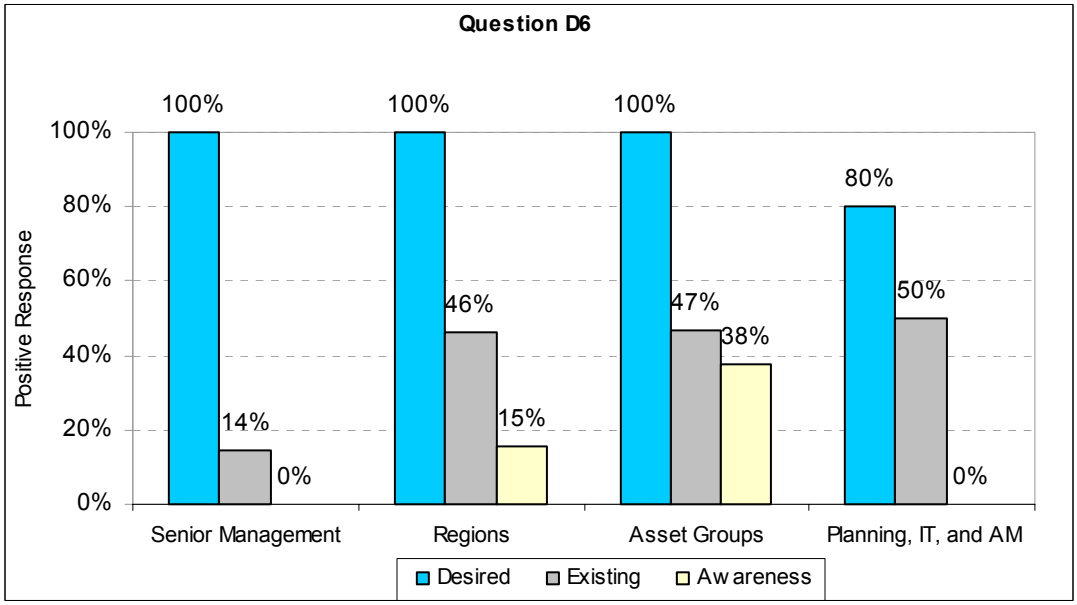
Improving the accuracy and reliability of data collection techniques will help to improve the strategic, tactical and operational level decisions made using that data.

Initiatives to be developed in Asset Management Strategy:

- Complete an internal data review to collect metadata describing the Data Quality Level (DQL) and the Analysis Quality Level (AQL) used at the strategic, tactical and operational level.
- Complete an evaluation of the costs and benefits associated with increasing the DQL and AQL where appropriate.

Timeline:	**Responsibility:**
One to Three Years	All

Figure D6: Our agency continually seeks to improve the quality and accuracy of data collected to make strategic, tactical and operational level decisions.



Discussion:

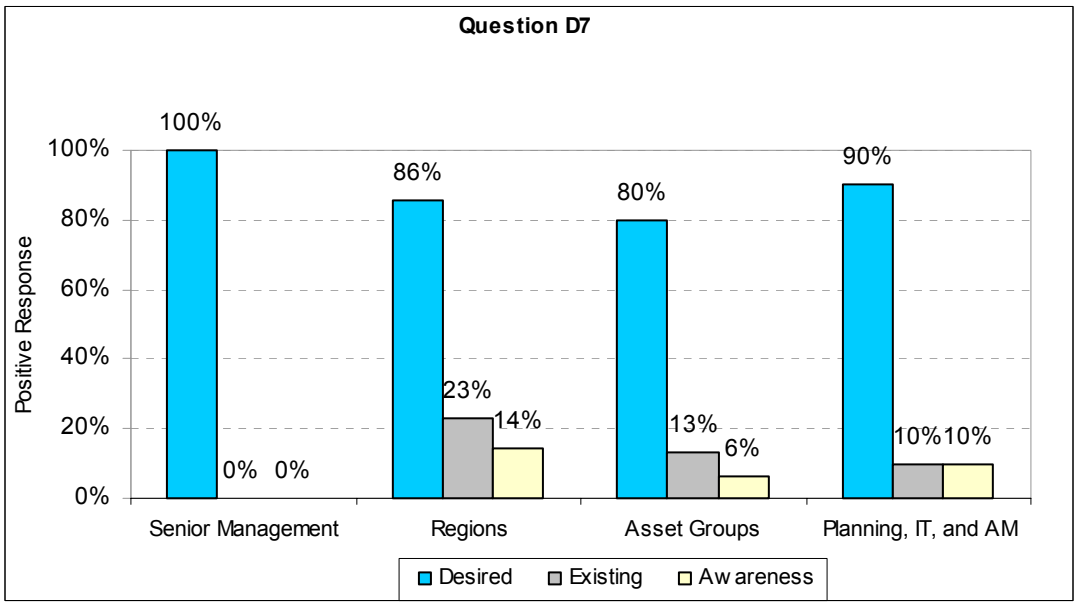
Improving the accuracy and reliability of data collection techniques will help to improve the strategic, tactical and operational level decisions made using that data.

Initiatives to be developed in Asset Management Strategy:

- Complete an internal data review to collect Meta data describing the Data Quality Level (DQL) and the Analysis Quality Level (AQL) used at the strategic, tactical and operational level.
- Complete an evaluation of the costs and benefits associated with increasing the DQL and AQL where appropriate.

Timeline:	**Responsibility:**
One to Three Years	All

Figure D7: Our agency periodically reviews the data collection policy for each asset to determine the cost effectiveness of the data being collected.



Discussion:

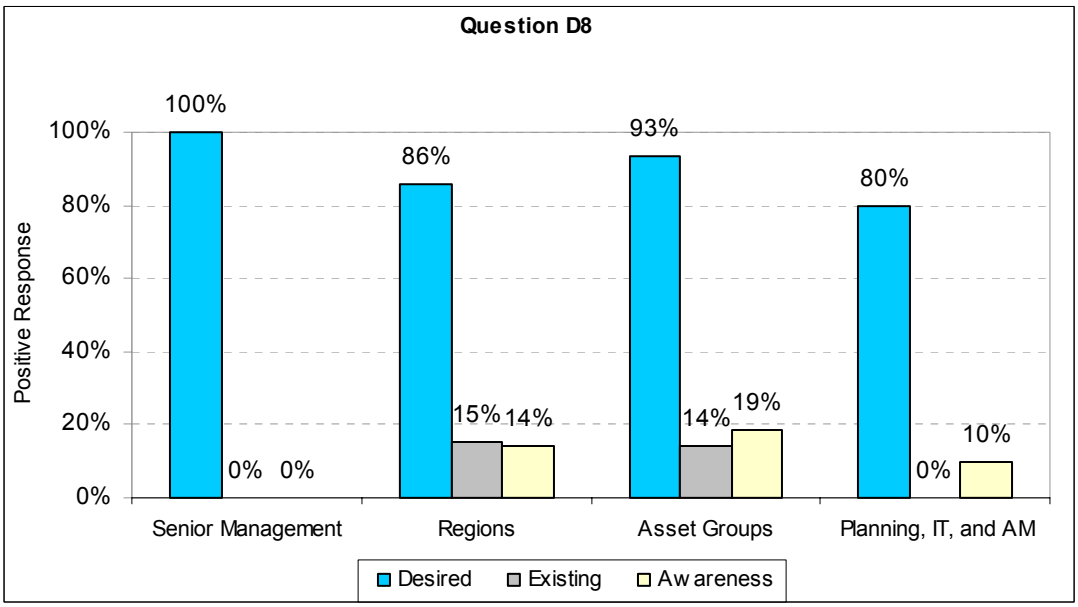
Improving the accuracy and reliability of data collection techniques will help to improve the strategic, tactical and operational level decisions made using that data.

Initiatives to be developed in Asset Management Strategy:

- Complete an internal data review to collect Meta data describing the Data Quality Level (DQL) and the Analysis Quality Level (AQL) used at the strategic, tactical and operational level.
- Complete an evaluation of the costs and benefits associated with the data being collected.

Timeline:	**Responsibility:**
One to Three Years	All

Figure D8: Our agency periodically reviews the data collection policy for each asset in various departments to reduce duplication and increase uniformity in data.



Discussion:

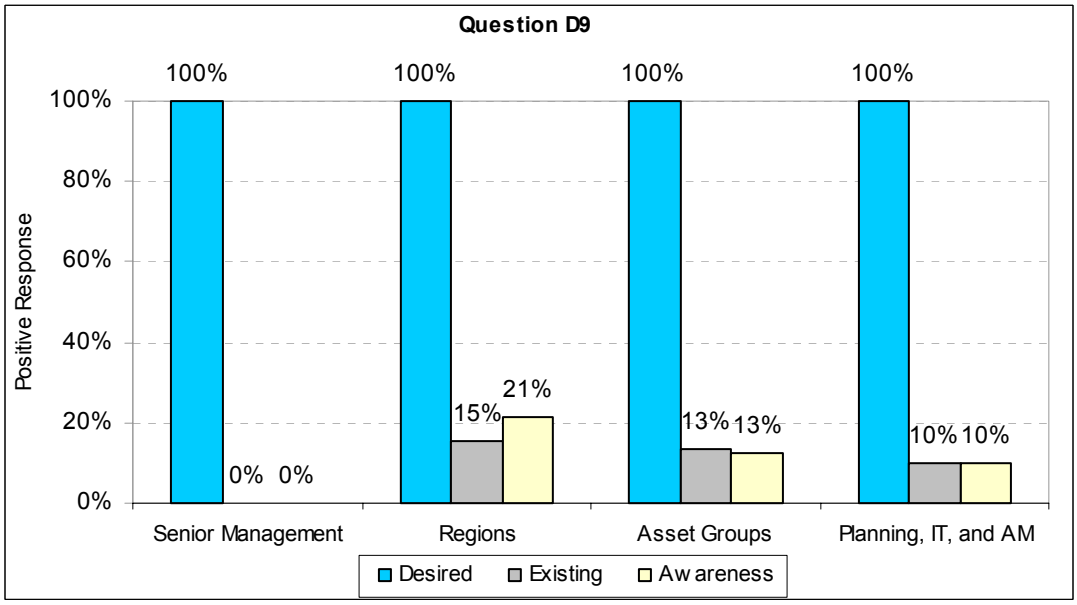
Uniformity of data within an agency will help improve the quality of the data and the information that results from the analysis of that data.

Initiatives to be developed in Asset Management Strategy:

- Complete an internal data review to collect Meta data describing how data is collected within the agency and how that data is used and analyzed.

Timeline:	**Responsibility:**
One to Three Years	All

Figure D9: Agency managers and staff at different levels can quickly and conveniently obtain information they need about asset characteristics, location, usage, condition and performance.



Discussion:

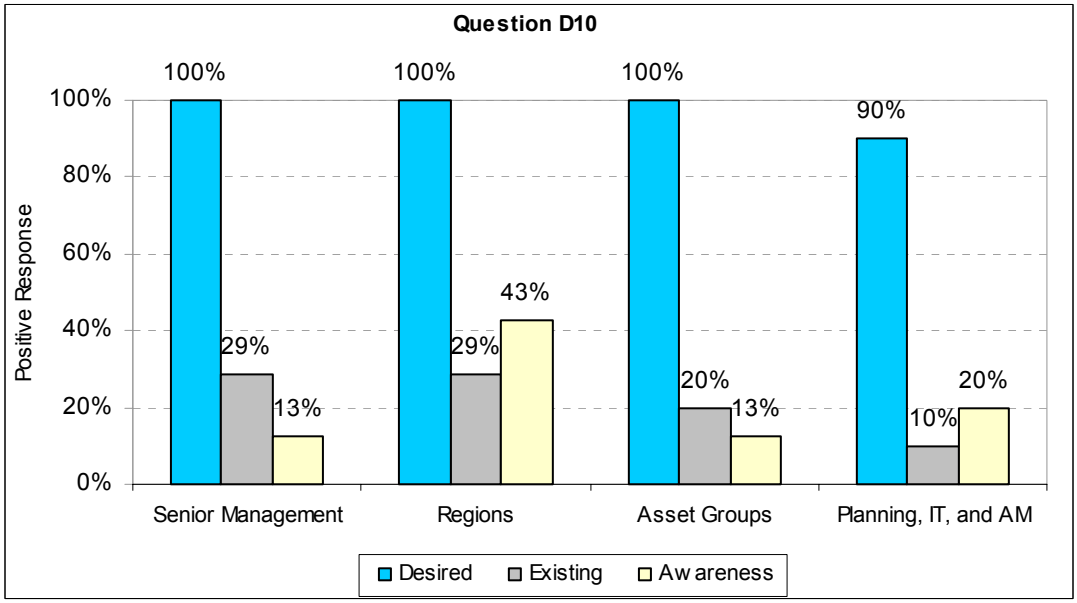
Data Integration and Access to Information is key to decision making at all levels within the organization.

Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level.
- Continued implementation of asset specific systems at the tactical and operational level.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Regions

Figure D10: Our agency has established standards for location referencing that allow us to bring together information for different asset classes.



Discussion:

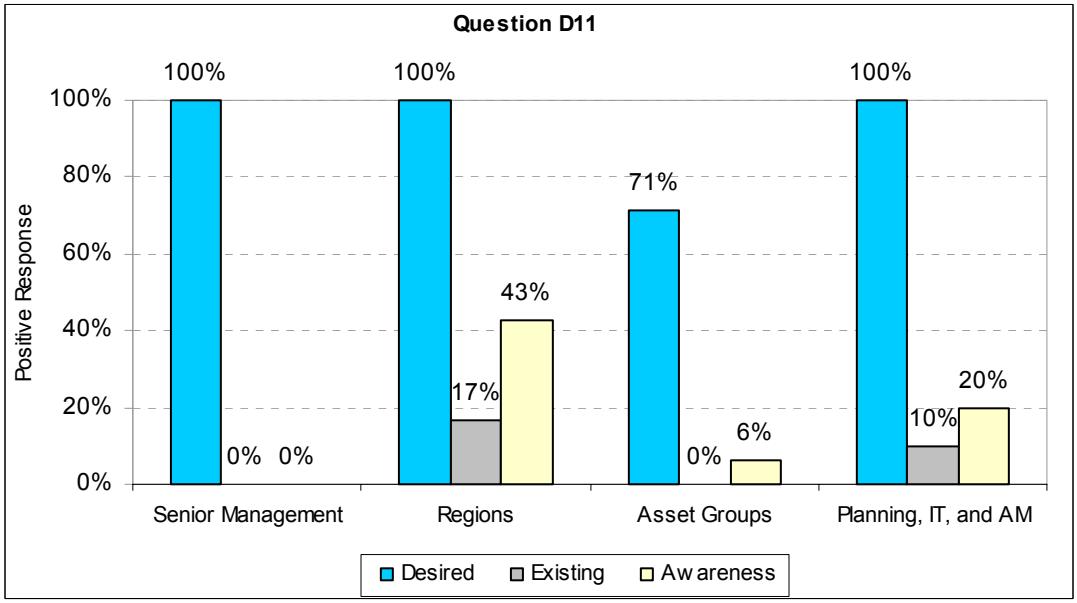
A unified standard location reference method or a working location reference system that can translate between different methods is important to improve data integration and data accessibility throughout UDOT.

Initiatives to be developed in Asset Management Strategy:

- Continue the work of the Location Referencing Committee to publish the Location Reference Standard and efforts to bring forward new asset group specific systems that can adopt the new standard or translate to it.
- Continued implementation of the Asset Repository within dTIMS CT, which can translate between different location reference methods.

Timeline:	**Responsibility:**
Immediate	All

Figure D11: Our agency strictly enforces compliance to location reference standards across decision support tools and departments.



Discussion:

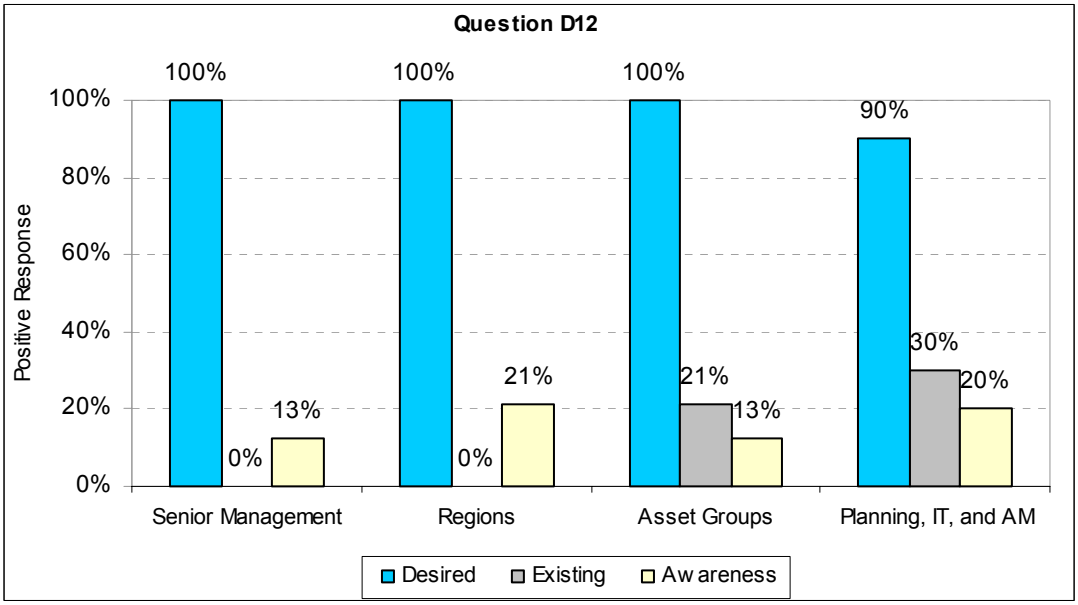
Compliance to; and enforcement of location reference standards helps ensure data accuracy and reliability in terms of its location.

Initiatives to be developed in Asset Management Strategy:

- Continue the work of the Location Referencing Committee to publish the Location Reference Standard and efforts to bring forward new asset group specific systems that can adopt the new standard or translate to it.
- Continued implementation of the Asset Repository within dTIMS CT, which can translate between different location reference methods.

Timeline:	**Responsibility:**
Immediate	All

Figure D12: Our agency can easily produce reports and maps showing needs and deficiencies for different asset classes and programmed projects.



Discussion:

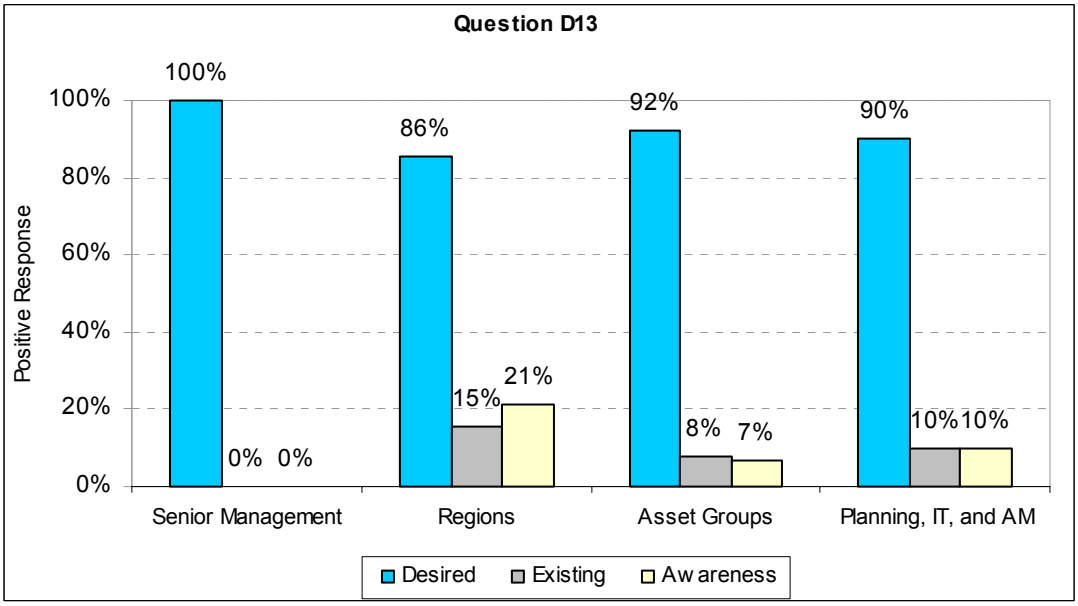
Data Integration and Access to Information is key to decision making at all levels within the organization.

Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level, which can integrate data from many departments using many different location reference methods.
- Coordinate the integration of data between the Asset Repository and the UDOT GIS.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and GIS

Figure D13: Our agency has established data standards to promote the consistent treatment of existing asset - related data and to guide development of future applications.



Discussion:

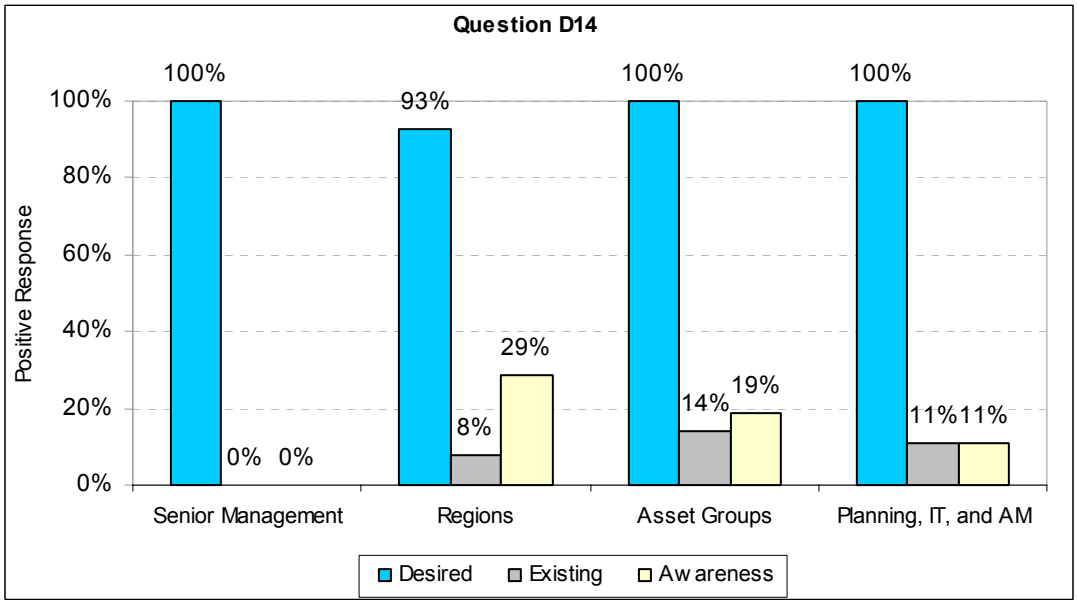
Data standards help ensure that data quality and accuracy is consistent throughout various asset groups and systems that are used to manage and analyze that data.

Initiatives to be developed in Asset Management Strategy:

- Complete an internal data review to collect Meta data describing the data and analysis completed for each asset.
- Develop and publish a set of standards describing the data required for each asset and how that data can be used in strategic, tactical and operational level analysis.

Timeline:	**Responsibility:**
Two to Four Years	All

Figure D14: Information on actual work completed and costs is used to improve the cost projection capabilities of our management systems at the strategic, tactical, and operational levels.



Discussion:

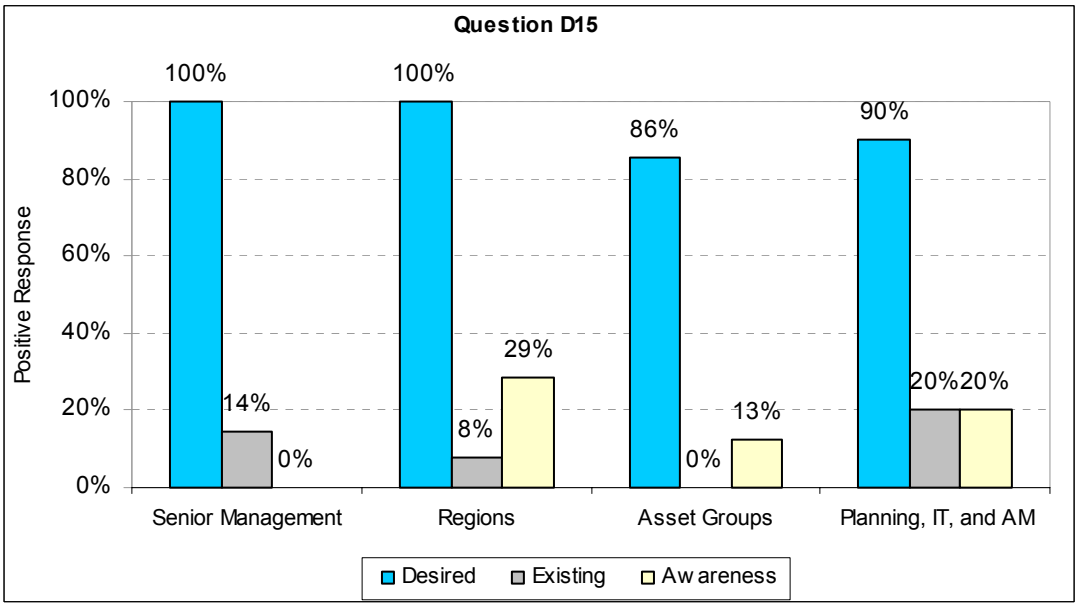
Accurate and reliable unit cost data is important for future project estimates and for current program delivery. If costing data is unreliable the results of strategic level asset management and planning and programming at the tactical and operational levels and can be disastrous.

Initiatives to be developed in Asset Management Strategy:

- Research and recommend enhancements to the current project tracking systems to ensure project costing information and project history information is accurate and reliable.
- Ensure that updated project cost information is available for any cost projections within the department.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Project Development

Figure D15: Information on changes in asset condition over time is used to improve forecasts of asset life and deterioration in our management systems at the strategic, tactical, and operational level.



Discussion:

Existing and historical asset condition data must be used regularly to update deterioration modeling to help improve the Analysis Quality Level at the strategic, tactical and operational levels.

Initiatives to be developed in Asset Management Strategy:

- Evaluate exiting deterioration modeling and update as necessary on an on-going basis.

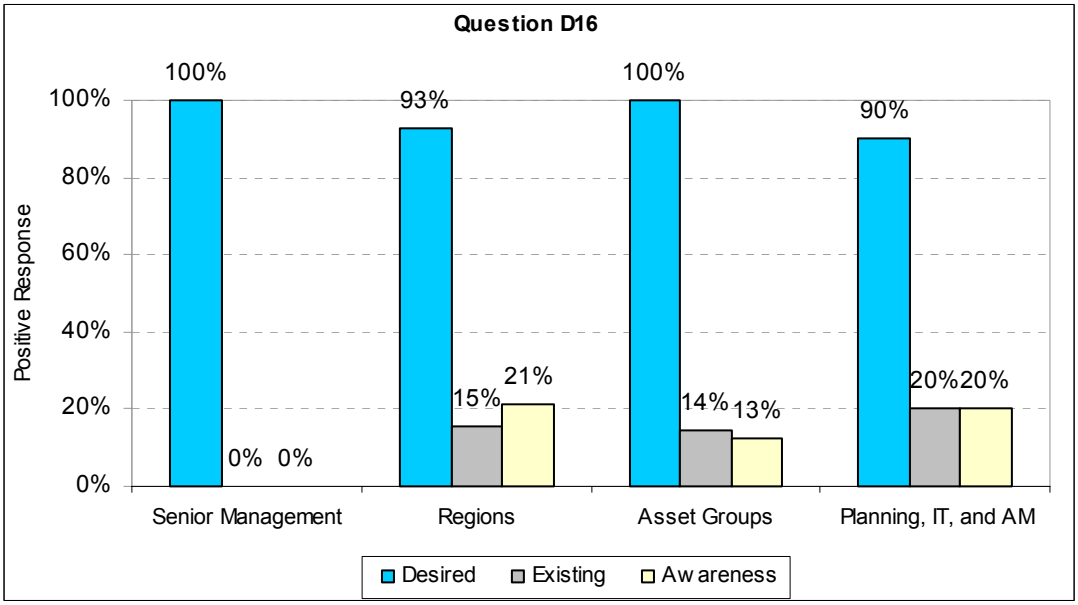
Timeline:

One to Three Years

Responsibility:

AM Team and Asset Groups

Figure D16: Our agency uses asset management decision support tools to calculate and report actual system performance.



Discussion:

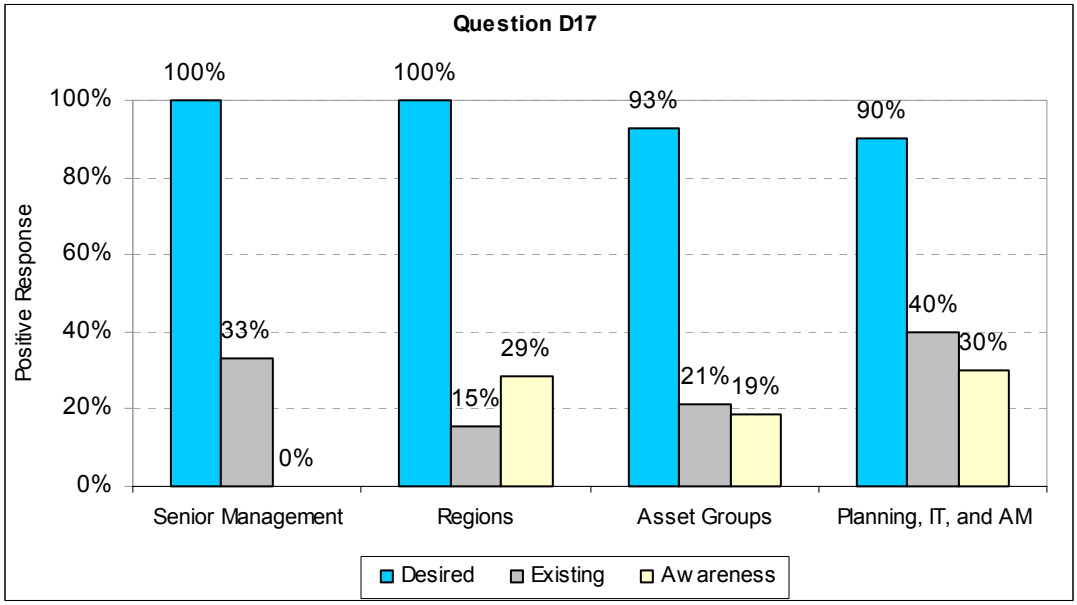
Decision support tools should be used to report actual system performance in relation to performance measures included in UDOT's strategic direction and planning.

Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in reporting system performance and these must be implemented within existing and future decision support tools.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	TRANSMAT, AM Team and Asset Groups

Figure D17: Our agency uses asset management decision support tools to identify system deficiencies or needs.



Discussion:

Decision support tools should be used to identify system performance deficiencies and needs in relation to performance measures in UDOT's strategic direction and planning.

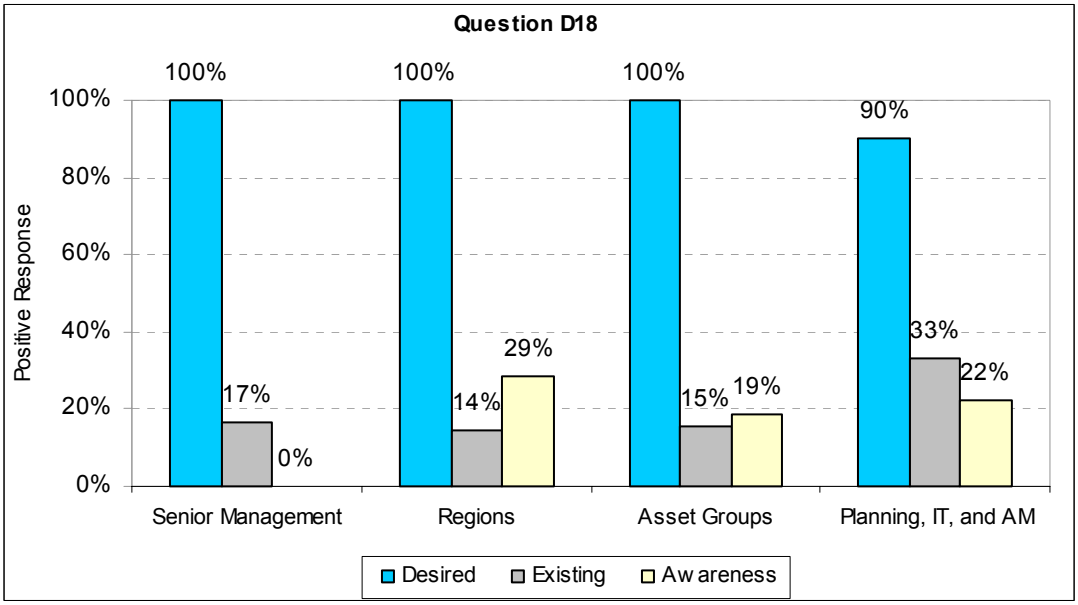
Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in reporting system performance and these must be implemented within existing and future decision support tools.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	TRANSMAT, AM Team and Asset Groups

Use of decision support tools

Figure D18: Our agency uses asset management decision support tools to rank candidate projects for the capital program.



Discussion:

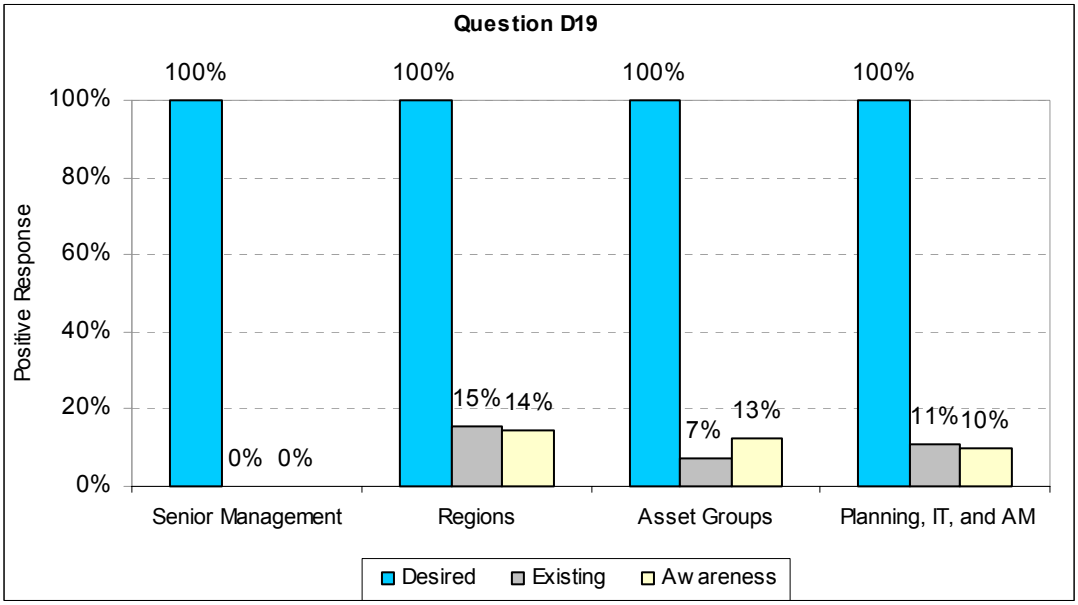
Decision support tools should be used to identify and rank candidate projects.

Initiatives to be developed in Asset Management Strategy:

- The asset repository and existing asset group systems should be utilized in identifying candidate projects at the strategic, tactical and operational levels.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Asset Groups

Figure D19: Our agency uses asset management decision support tools to forecast future system performance given a proposed program of projects.



Discussion:

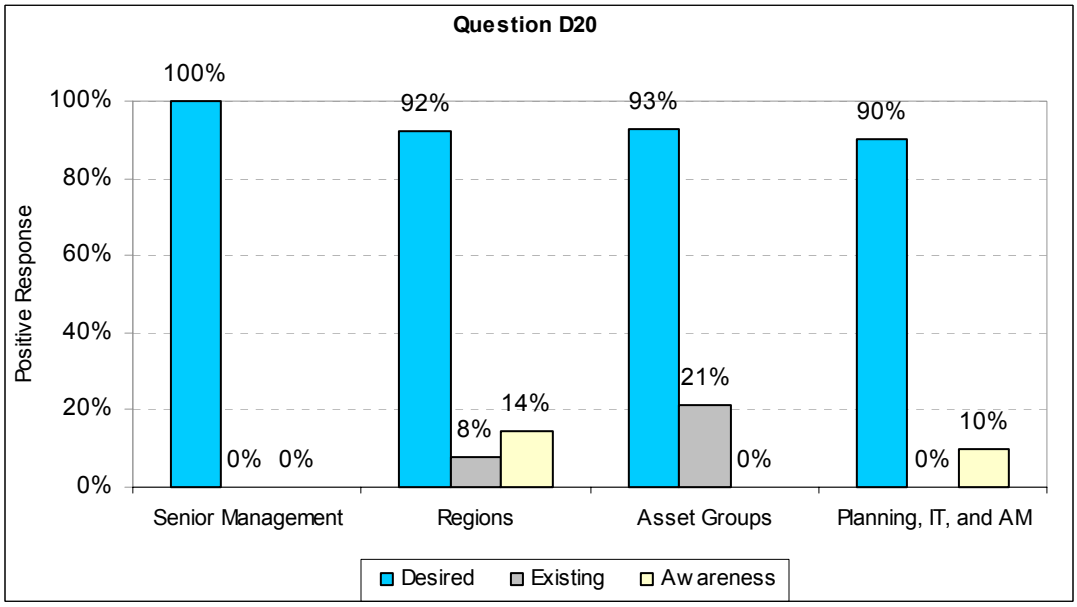
Decision support tools should be used to forecast and report system performance based on planned and programmed work.

Initiatives to be developed in Asset Management Strategy:

- The asset repository and existing asset group systems should be utilized in forecasting and reporting system performance based on planned and programmed work.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Asset Groups

Figure D20: Our agency uses asset management decision support tools to forecast future system performance under different mixes of investment levels by program category.



Discussion:

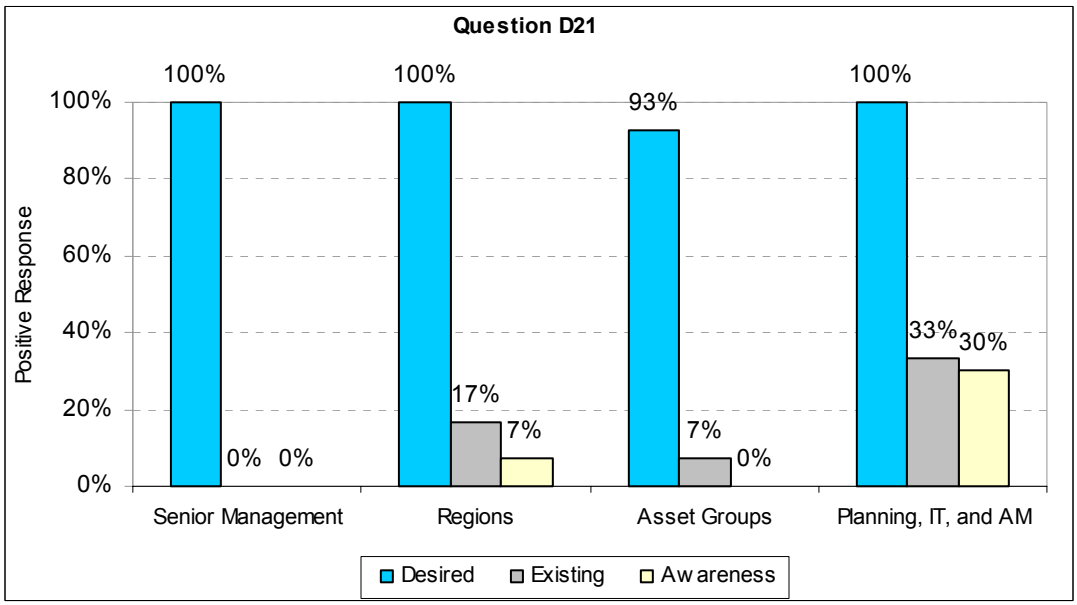
Decision support tools should be used to forecast and report system performance based on different investment levels by program category.

Initiatives to be developed in Asset Management Strategy:

- The asset repository and existing asset group systems should be utilized in forecasting and reporting system performance based on different investment levels by program category.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Asset Groups

Figure D21: Our agency monitors actual system performance and compares these values to targets projected for its capital preservation program.



Discussion:

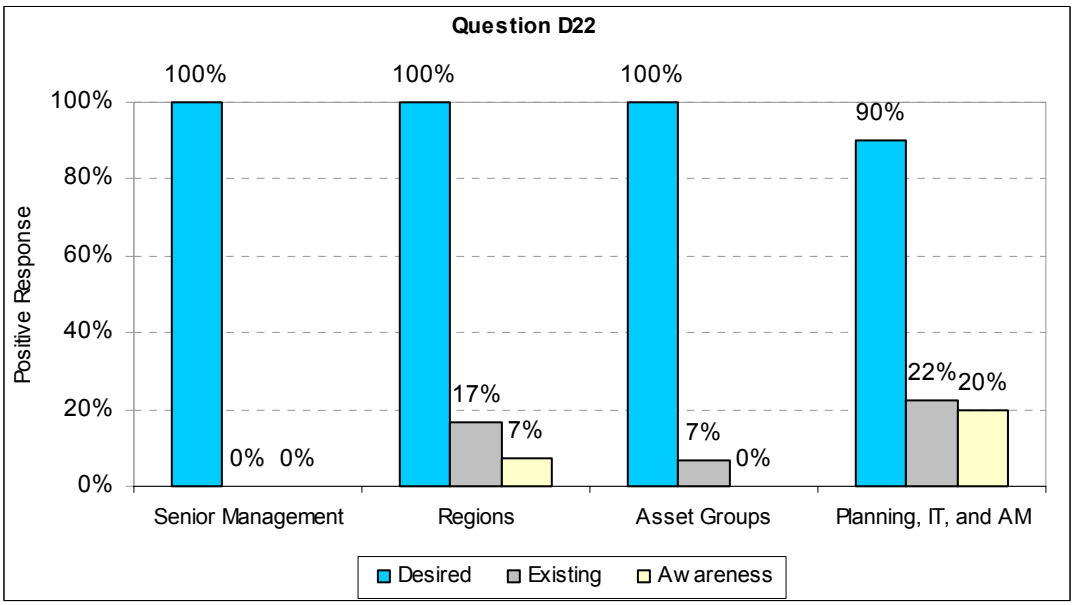
Decision support tools should be used to forecast and report actual system performance compared to target performance. This information can then be used to communicate program delivery successes and areas where improvements are required.

Initiatives to be developed in Asset Management Strategy:

- The asset repository and existing asset group systems should be utilized in forecasting and reporting system performance based on different investment levels by program category.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Asset Groups

Figure D22: Our agency monitors actual system performance and compares these values to targets projected for its capital improvement program.



Discussion:

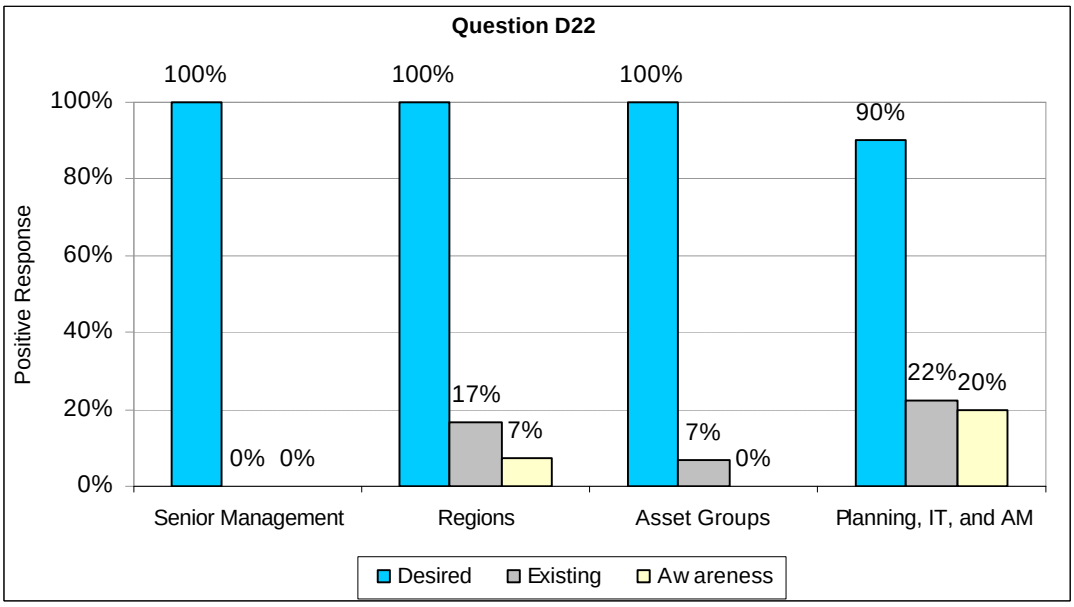
Decision support tools should be used to forecast and report actual system performance compared to target performance. This information can then be used to communicate program delivery successes and areas where improvements are required.

Initiatives to be developed in Asset Management Strategy:

- The asset repository and existing asset group systems should be utilized in forecasting and reporting system performance based on different investment levels by program category.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Asset Groups

Figure D22: Our agency monitors actual system performance and compares these values to targets projected for its capital improvement program.



Discussion:

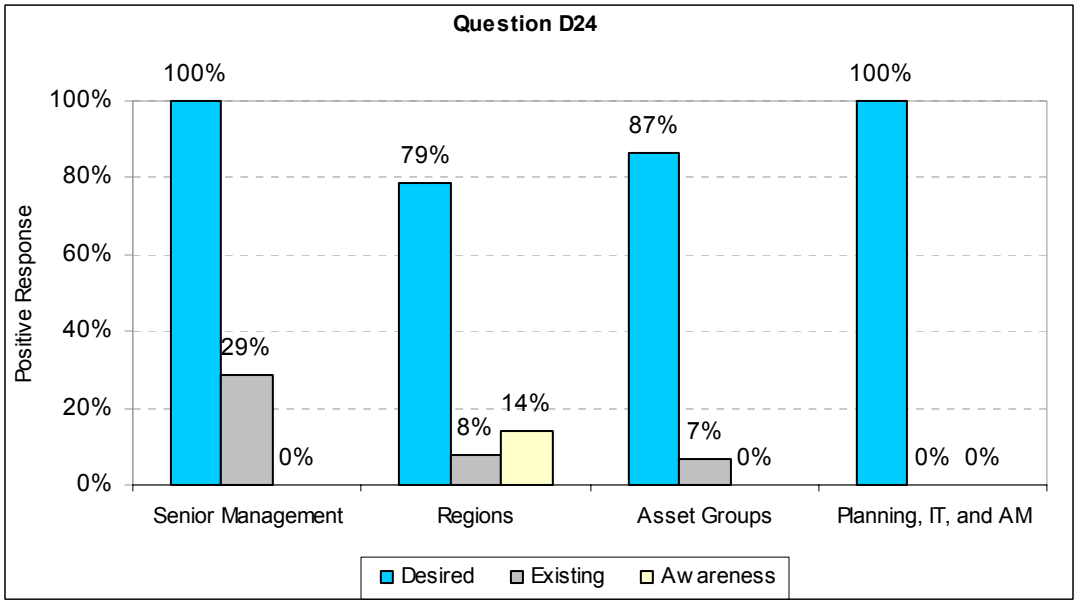
Decision support tools should be used to forecast and report actual system performance compared to target performance. This information can then be used to communicate program delivery successes and areas where improvements are required.

Initiatives to be developed in Asset Management Strategy:

- The asset repository and existing asset group systems should be utilized in forecasting and reporting system performance based on different investment levels by program category.
- Where no decision support tools exist for individual asset groups, tools will be investigated and implement where appropriate.

Timeline:	**Responsibility:**
One to Three Years	AM Team and Asset Groups

Figure D24: Our agency periodically distributes reports of performance measures relevant to customer and stakeholder satisfaction with transportation system and services.



Discussion:

Keeping external stakeholders and policy makers updated and informed on current performance measures helps to strengthen credibility, accountability and communicate good stewardship with external stakeholders.

Initiatives to be developed in Asset Management Strategy:

- Ensure that the project and overall strategic status reports are periodically released to external stakeholders.

Timeline:

One to Three Years

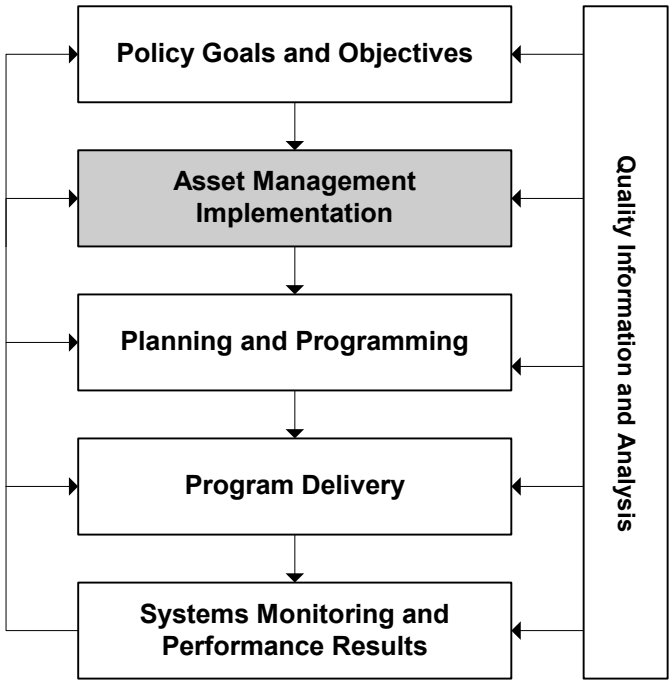
Responsibility:

AM Team and Program Development

4.E Asset Management Implementation

Overview: The main role of the Asset Management team is to supply the Planning section with information on strategic, cross-asset analysis and optimization for the Long Range Plan. Other responsibilities should include: developing a strategy and action plan, maintaining a central asset repository (database), coordinating with the various levels of the department (planning to tactical to operational), coordinating with existing "legacy" management systems (PONTIS, etc), coordinating with other agencies, and sharing knowledge so that asset management can improve within and outside of UDOT. Theses questions help define the role of the Asset Management Team.

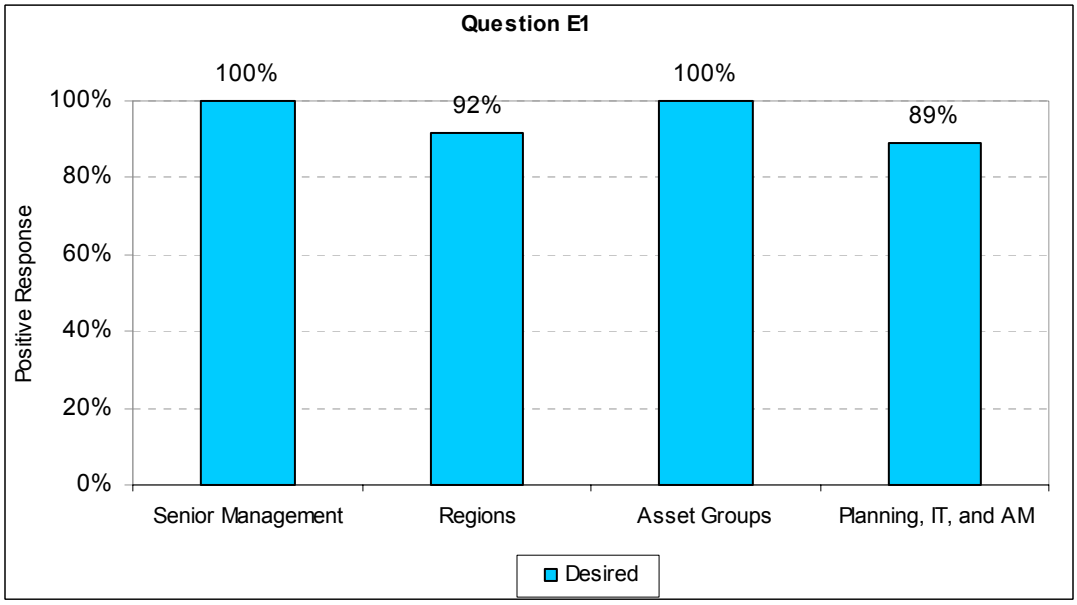
Figure E. Resource Allocation and Utilization – Asset Management Implementation



Asset Management Areas

- **Improvement Strategy and Action Plan**
- **Central Asset Repository**
- **Cross-Asset Analysis and Optimization**
- **Coordination from LRP to Tactical to Operational**
- **Coordination with management systems**
- **Knowledge sharing**

Figure E1: To ensure success and guarantee the benefits of Asset Management, UDOT Senior Leaders will support and fund initiatives by TRANSMAT and the Asset Management Team for a minimum of three years.

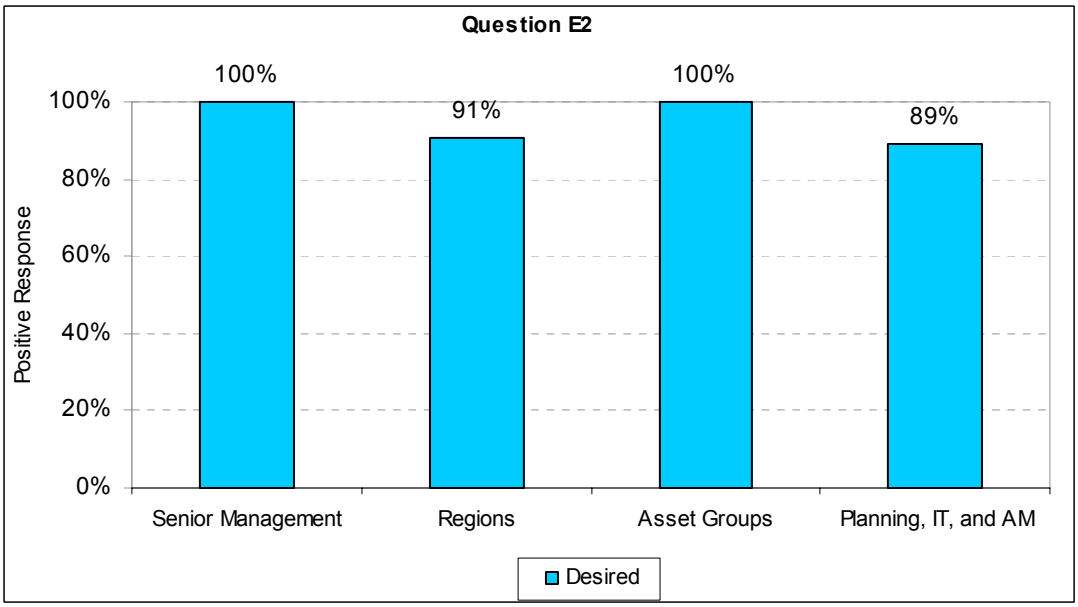


Discussion:

In order to be effective, the AM Team needs at least three years to implement and establish selected best practice components of asset management within UDOT. Support for a minimum of three years ensures that selected components requiring a long-term approach to implementation are seen from concept through to completion.

The survey responses to question E1 confirm support for the AM Team and its initial approach to the implementation.

Figure E2: The Asset Management team will formulate an improvement strategy and action plan to improve the implementation of asset management within UDOT. TRANSMAT will finalize, approve, fund and support improvement projects throughout the department to accomplish this strategy.



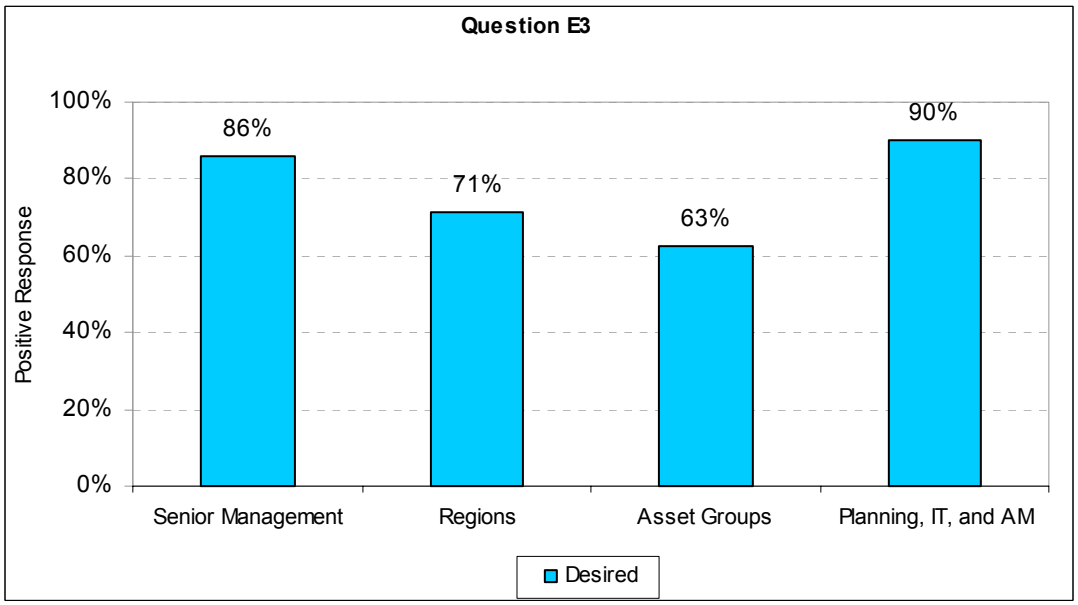
Discussion:

The AM Team will use the survey results and subsequent discussions with members of TRANSMAT to formulate an improvement strategy and action plan to implement asset management within UDOT.

The survey responses to question E2 confirm support for the AM Team and its initial approach to the implementation.

Timeline:	**Responsibility:**
Immediate	AM Team

Figure E3: The Asset Management team will be responsible for maintaining an asset repository to serve as the official asset register for UDOT.



Discussion:

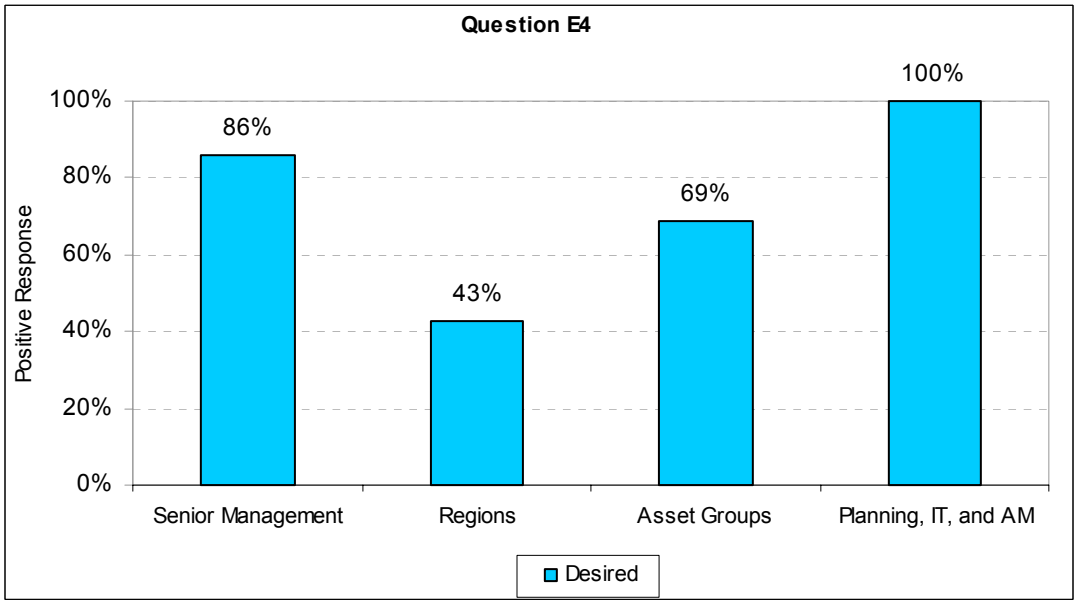
The need for an up-to-date and accurate asset inventory including classification, condition, performance and use data (where appropriate) is an important first step towards developing an asset management system.

Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level.
- Continued implementation of asset specific systems at the tactical and operational level.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Regions

Figure E4: The Asset Management team will be responsible for performing the cross-asset analysis & optimization to determine recommended funding allocations at strategic level.



Discussion:

The Asset Repository will contain the cross asset analysis and optimization functionality necessary to perform economic trade-off analysis. This decision support tool will enable UDOT to investigate trade-offs within asset groups (maintenance versus rehabilitation versus replacement) and across asset groups (pavements versus bridges versus signs versus guard rails).

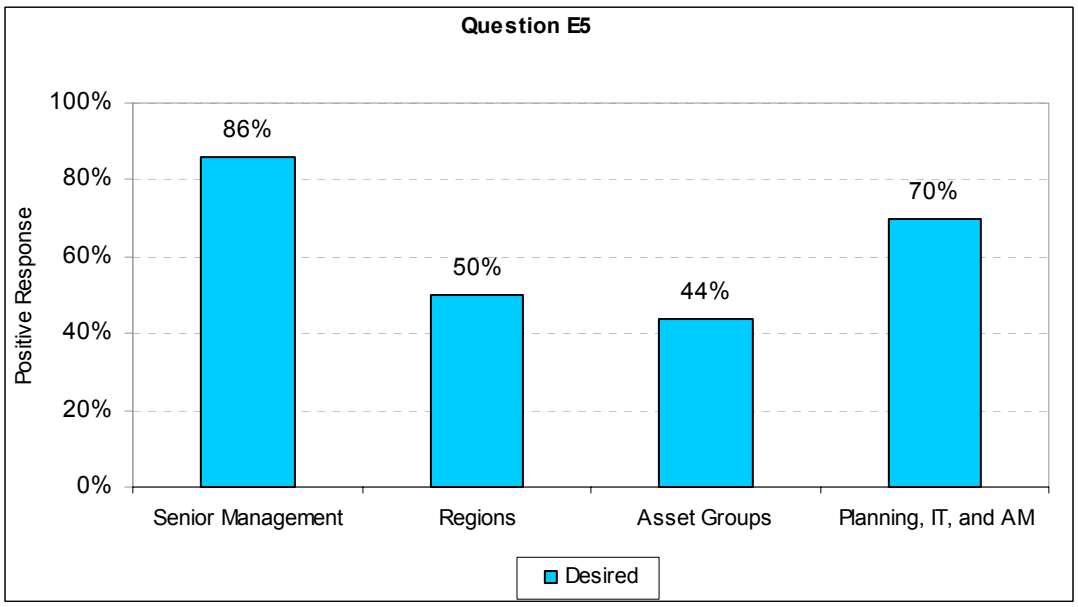
Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level.
- Continued implementation of asset specific systems at the tactical and operational level.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Regions

Funding allocations from cross-asset optimization applied from LRP to tactical and operational areas

Figure E5: The funding allocations that result from the cross asset optimization will be used in the formulation of the long-range plan.



Discussion:

The Asset Repository will contain the cross asset analysis and optimization functionality necessary to perform economic trade-off analysis. This decision support tool will enable UDOT to investigate trade-offs within asset groups (maintenance versus rehabilitation versus replacement) and across asset groups (pavements versus bridges versus signs versus guard rails).

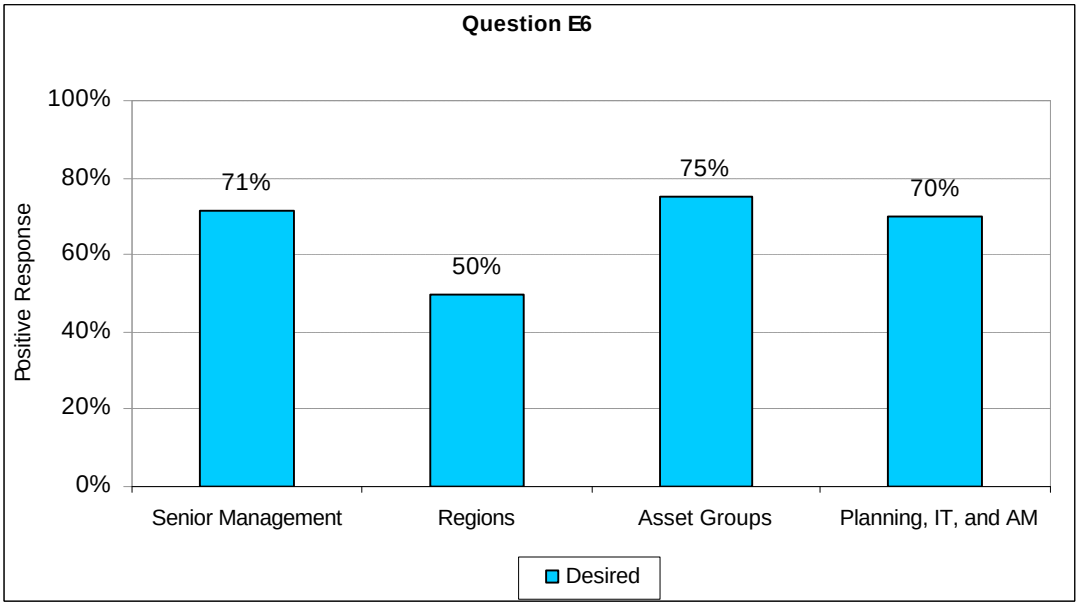
Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level.
- Continued implementation of asset specific systems at the tactical and operational level.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Regions

Funding allocations from cross-asset optimization applied from LRP to tactical and operational areas

Figure E6: The funding allocations that result from the cross asset optimization will be used in the formulation of the asset preservation plans at the tactical and operational levels.



Discussion:

The Asset Repository will contain the cross asset analysis and optimization functionality necessary to perform economic trade-off analysis. This decision support tool will enable UDOT to investigate trade-offs within asset groups (maintenance vs. rehabilitation vs. replacement) and across asset groups (pavements vs. bridges vs. signs vs. guard rails).

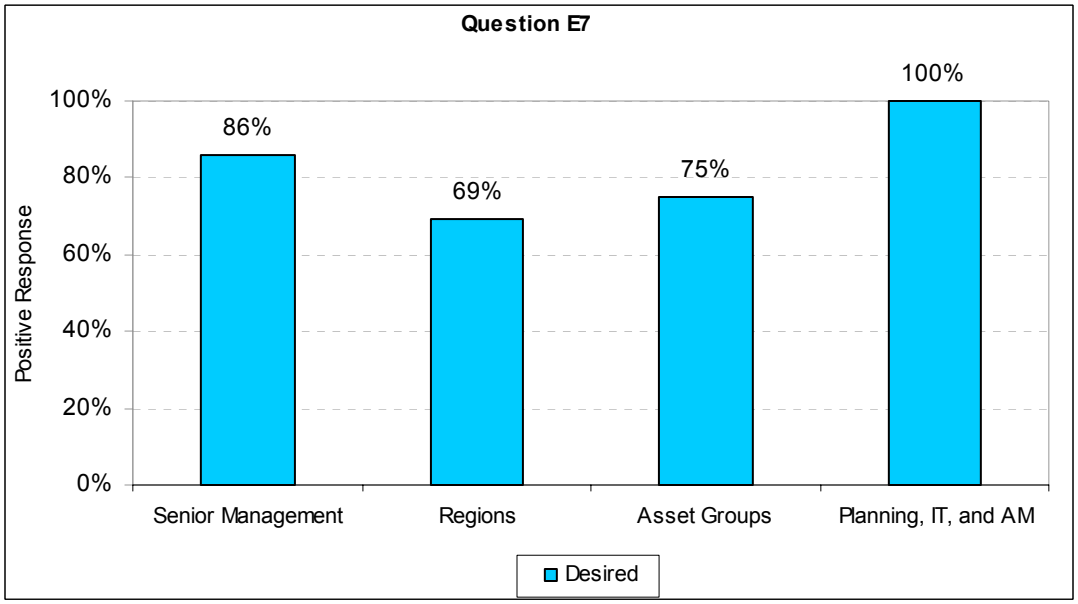
Initiatives to be developed in Asset Management Strategy:

- Continued implementation of the Asset Repository within dTIMS CT at the strategic level.
- Continued implementation of asset specific systems at the tactical and operational level.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups and Regions

Asset Management team coordination with management systems and tactical and operational areas

Figure E7: The Asset Management team will coordinate between the management systems to ensure tactical and operational programs are delivered in conjunction with strategic objectives.



Discussion:

Coordination across organizational units is necessary to ensure that tactical and operational level program deliveries are consistent with overall UDOT strategic objectives. It is imperative that someone coordinates program development and delivery to ensure harmony and compliance between the strategic direction of UDOT and the direction actually taken.

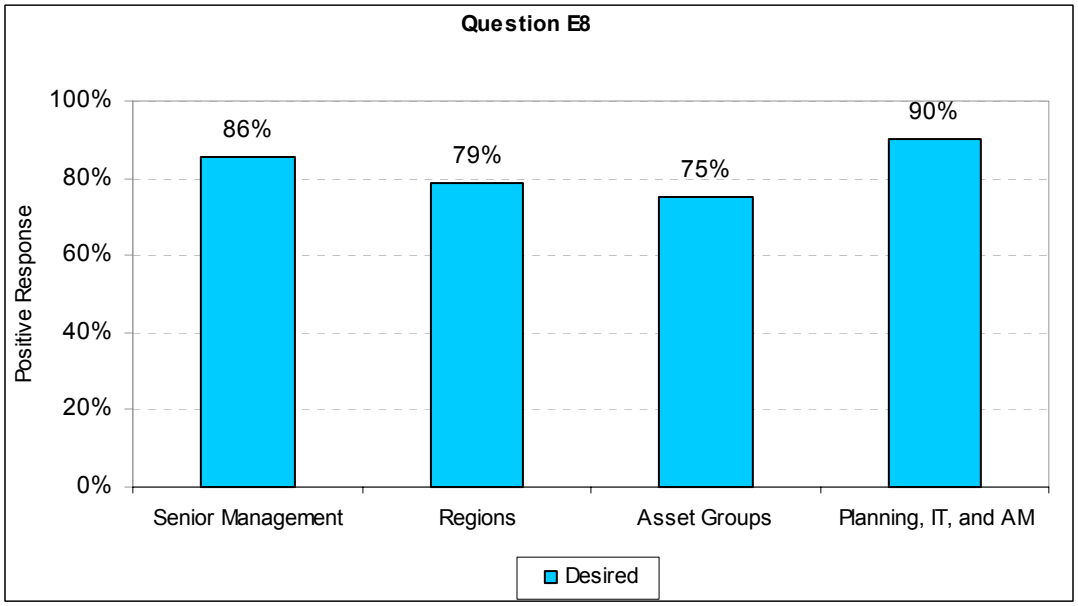
Initiatives to be developed in Asset Management Strategy:

- Coordinate through TRANSMAT the strategic direction and help ensure this is continued throughout program development and delivery.

Timeline:	**Responsibility:**
Immediate	All

Asset Management team coordination with management systems and tactical and operational areas

Figure E8: The Asset Management team will assist tactical and operational level areas in improving the data and analysis models used at the respective levels and then at the strategic level.



Discussion:

Data and analysis models will flow upwards from the tactical and operational level areas for use in the strategic analysis. The AM Team will help coordinate studies, enhancements and improvements to the data and analysis models at the tactical and operational levels, which will then flow up to the strategic level.

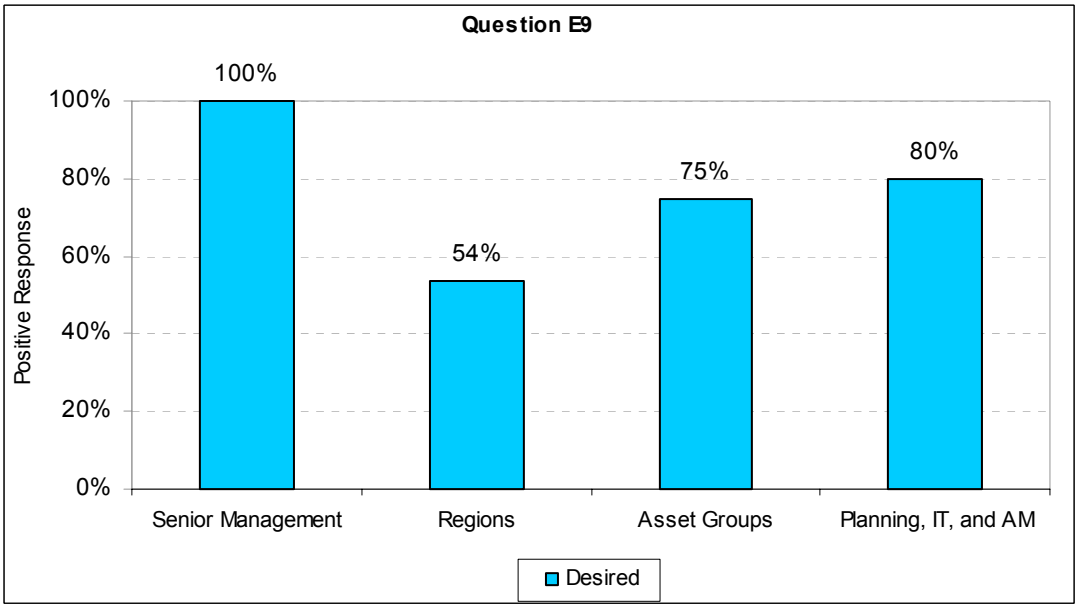
Initiatives to be developed in Asset Management Strategy:

- Policies and procedures outlining the process to review and improve upon data and models used at various levels within the department.

Timeline:	**Responsibility:**
One to Three Years	TRANSMAT, AM Team and Asset Groups

Asset Management team coordination with management systems and tactical and operational areas

Figure E9: The Asset Management team will coordinate the development and implementation of Key Performance Indexes (KPIs) to be used at all levels of analysis.



Discussion:

UDOT needs to develop performance measures or key performance indexes (KPIs) to measure and publicize progression towards the strategic goals and objectives outlined in UDOT's strategic direction.

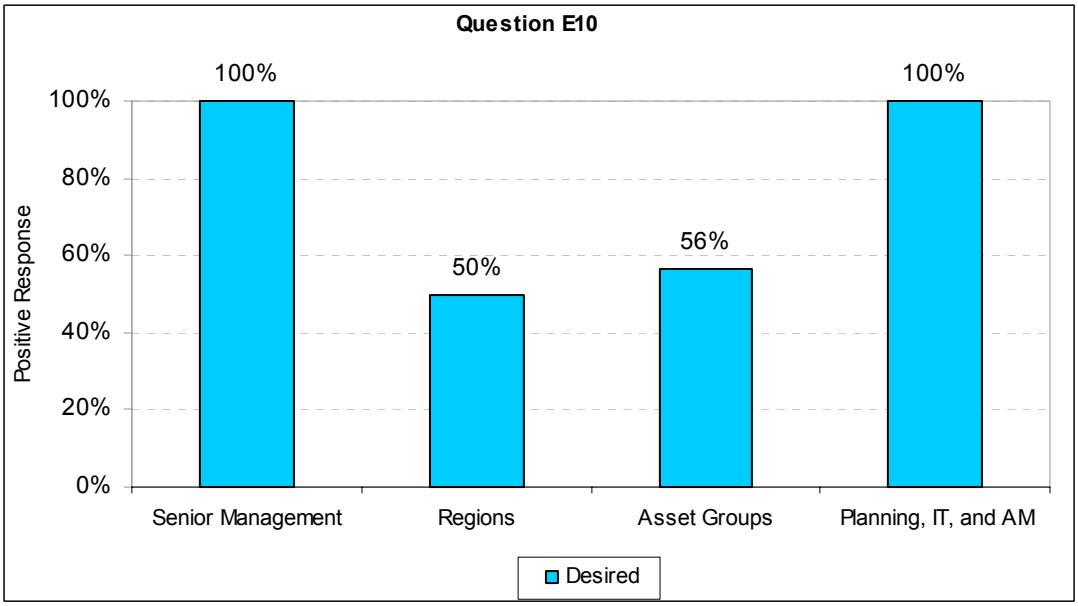
Initiatives to be developed in Asset Management Strategy:

- Performance measures must be developed to aid in resource allocation in conjunction with UDOT's strategic direction.

Timeline:	**Responsibility:**
One to Three Years	TRANSMAT, AM Team and Asset Groups

Asset Management team coordination with management systems and tactical and operational areas

Figure E10: The Asset Management team will coordinate the development and implementation of new analysis techniques and analysis methodologies that can be used at all levels of analysis.



Discussion:

Keeping abreast of developments within the science of asset management will allow UDOT more flexibility within its cross asset analysis and optimization and will enable UDOT to adopt new technologies quicker and easier.

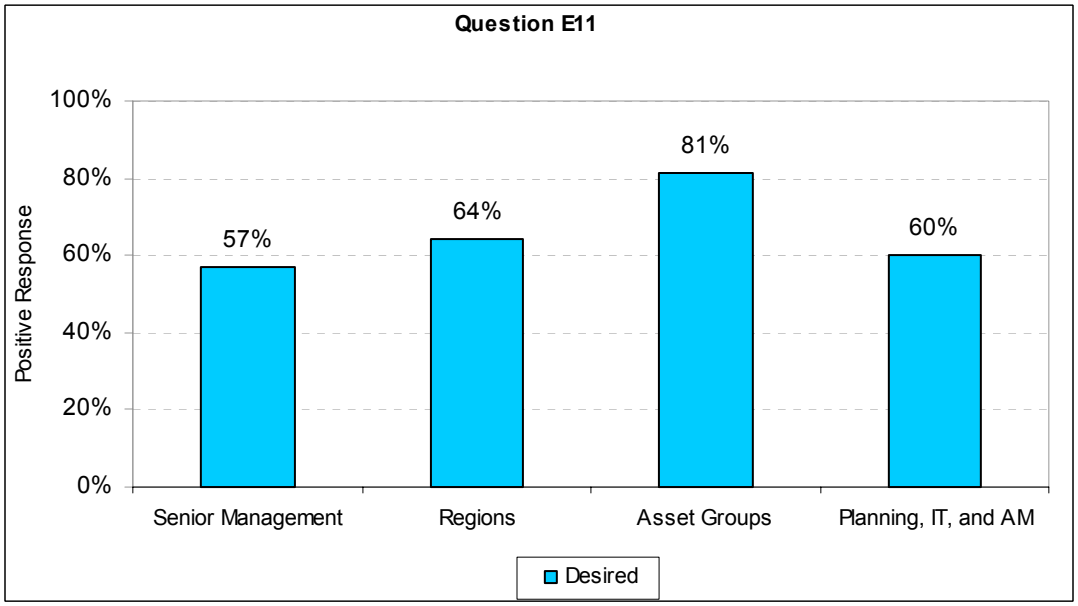
Initiatives to be developed in Asset Management Strategy:

- None required.

Timeline:	**Responsibility:**
Immediate	AM Team, Asset Groups

Asset Management team coordination with management systems and tactical and operational areas

Figure E11: The Asset Management team will coordinate and assist with the implementation of management systems at the operational levels where no existing systems are in place but are desired.



Discussion:

Where no management systems exist at the operational level and where a system is desired, the AM Team should coordinate and assist with the implementation of the management system. This is a logical course of action as the AM Team is coordinating asset management initiatives throughout UDOT.

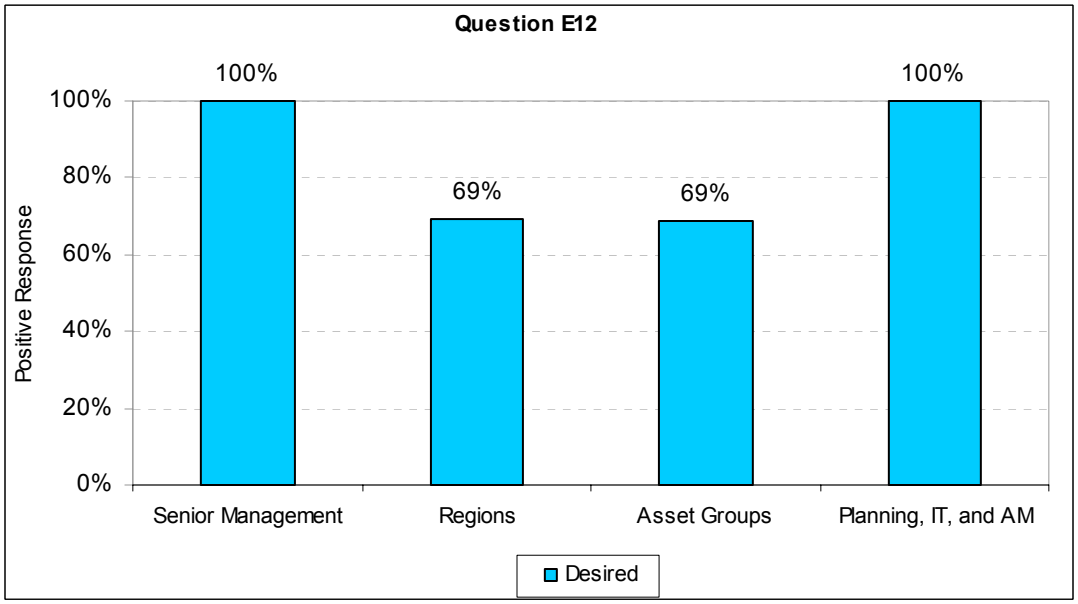
Initiatives to be developed in Asset Management Strategy:

- None required.

Timeline:	**Responsibility:**
Immediate	AM Team

Asset Management team will share knowledge with other transportation agencies and local governments

Figure E12: The Asset Management team will liaison with the FHWA and other transportation agencies to share information and knowledge to further the development of asset management in UDOT and in the United States.



Discussion:

This is a logical course of action as the AM Team is coordinating asset management initiatives throughout UDOT.

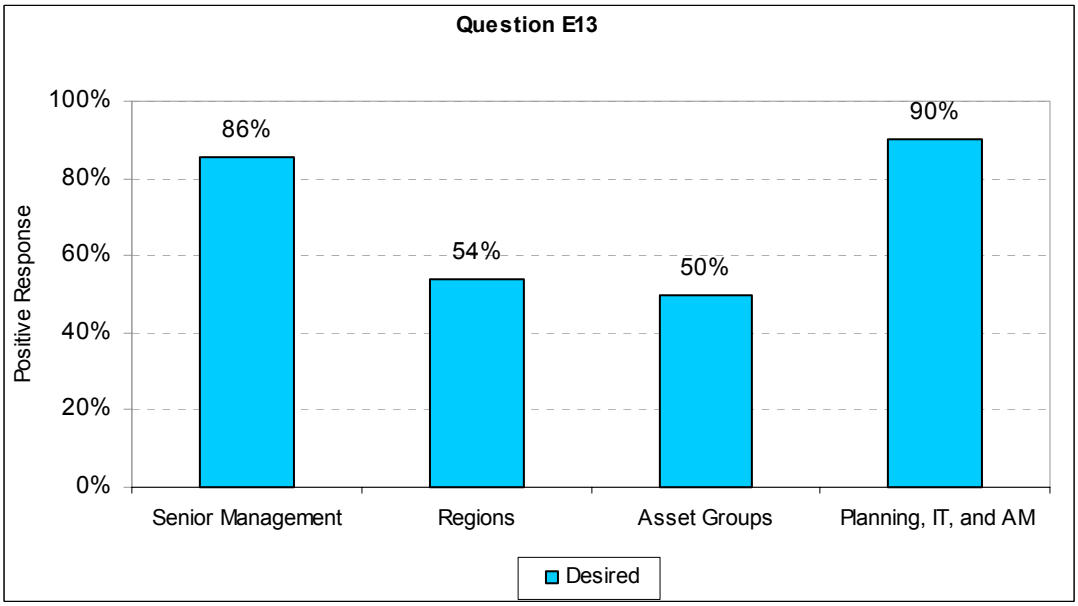
Initiatives to be developed in Asset Management Strategy:

- None required.

Timeline:	**Responsibility:**
Immediate	AM Team

Asset Management team will share knowledge with other transportation agencies and local governments

Figure E13: The Asset Management team will liaison with local governments to share information and knowledge to further the development of asset management in Utah.



Discussion:

This is a logical course of action as the AM Team is coordinating asset management initiatives throughout UDOT.

Initiatives to be developed in Asset Management Strategy:

- None required.

Timeline:	**Responsibility:**
Immediate	AM Team

For areas where there is a low level of desired implementation, respondent groups should gain education and have positive experiences in order to increase their desired level of implementation. For areas where there are large gaps between existing and desired levels of implementation, respondent groups should use the diagnostic charts provided in this section in order to determine how to narrow the gaps. The "Solutions" column refers to sections in the NCHRP report, which are provided in the appendix.

Figure 5.1 Diagnostic Tables

Policy guidance benefiting from good asset management (A1-A5)		
Benchmark	**Common Problems**	**Solutions**
Policies allow agency latitude in its resource allocation decisions. Policy guidance supports decisions based on cost-effectiveness or cost/benefit Policy guidance supports a long-term life-cycle approach to evaluating investments.	Most policy debate is about specific project choices and not about broader outcomes Changes in leadership make sustained initiatives difficult No clear relationship between policies and how resource allocation decisions are made Implications of policies are unknown	Sections 5.3 Improved Policy-Making Section 5.5 Playing a proactive role in policy formulation

Strong framework for performance based resource allocation (A6-A8)		
Benchmark	**Common Problems**	**Solutions**
Comprehensive policy goals exist, with clear linkages to specific objectives and performance measures Policy guidance encourages resource allocation based on performance Policy guidance is well understood and reflected in business practices	Policies not aligned with more specific objectives or performance measures Internal and external policy guidance are not in alignment Funding decisions based purely on geography or history	Section 5.4 Relating policy to performance

Proactive role in policy formulation (A9-A13)		
Benchmark	**Common Problems**	**Solutions**
Agency clearly communicates current system performance with respect to policy goals and objectives to policy-makers and customers Agency proactively presents policy choices and implications to policy-makers Agency has latitude to make investment decisions based on performance	DOT lacks credibility with legislature or executive branch External guidance is overly specific, e.g., includes lists of specific projects or funding allocations Front-line decisions not consistently in line with priorities	Section 5.4 Relating policy to performance Section 5.5 Playing a proactive role in policy formulation

Consideration of alternatives in planning and programming (B1-B3)		
Benchmark	**Common Problems**	**Solutions**
Long-range plan evaluates capital, operational, and modal alternatives Capital-maintenance tradeoffs explicitly considered Current financial data used to develop project cost estimates and management system cost models	Lack of analysis of alternative approaches to problems Requiring long-term solutions Implications of different investment levels and mixes are not analyzed Lack of understanding of appropriate levels of maintenance versus capital investment	Section 6.2 Long-Range Planning Section 6.3 Capital Programming Section 7.4 Cost Tracking

Performance based planning & clear link among policy, planning, & programming (B4-B7)		
Benchmark	**Common Problems**	**Solutions**
Long-range plan is consistent with goals and objectives and realistic revenue projections Long-range plan provides clear guidance to programming process Project selection and resource allocation methods reflect current policies and priorities	Inability to translate policies into performance criteria Focusing too early on only one solution at project level Projects selected with poorly defined scopes, budgets, and schedules	Section 6.2 Planning Section 6.3 Capital Programming Section 6.4 Program Structure

Performance based programming process (B8-B13)		
Benchmark	**Common Problems**	**Solutions**
Candidate projects evaluated on benefit, cost, or performance impacts Project selection based on merit and considers least-life-cycle cost approaches Alternative maintenance levels of service defined and evaluated	Outcome-based performance measures not defined for all program categories Equity and political concerns have limited use of performance-based Approach Criteria for project selection not clearly aligned with stated performance measures	Section 6.3 Capital Programming Section 6.5 Maintenance and Operations Programming

Ensuring the proper state transportation network (B14-B15)		
Benchmark	**Common Problems**	**Solutions**
Highway system is consistent with policy goals and objectives If roads do not meet requirements according to policy goals and objectives they are transferred out of state jurisdiction	Some funds are used to preserve a highway system that is not part of the agency's mission Available funding is diluted Policies are unknown and/or not enforced	Policy clearly defines the characteristics of roads that should be included within State jurisdiction Agency publishes clear policy and supports enforcement of it Highway system should be monitored and transfers made as appropriate

Consideration of alternative project delivery mechanisms (C1-C2)		
Benchmark	**Common Problems**	**Solutions**
Options for delivering programs and services are periodically considered and evaluated	Standard bid process used for all construction projects; options not evaluated No process in place to explore resource sharing or outsourcing options to improve maintenance cost-effectiveness	Section 7.2 Alternative Delivery Methods

Effective program management (C3-C9)		
Benchmark	**Common Problems**	**Solutions**
Performance measures used to track program delivery Data used to make adjustments to program and delivery processes All stakeholders informed of program status	Insufficient review process to keep program changes in check and manage their impacts Program delivery indicators not reported regularly or used as effective management tool	Section 7.3 Program Management Section 8.5 Systems Monitoring and Feedback

Cost tracking and estimating (C10-C11)		
Benchmark	**Common Problems**	**Solutions**
Total costs of delivering programs and services are known by activity Current financial data used to develop project cost estimates and management system cost models	Lack of consistent breakdowns of activities and resources used for cost tracking No method in place to determine indirect cost allocations for activities Cost tracking information not in a form useful for budgeting, investment analysis, or asset management system cost model updates	Section 7.4 Cost Tracking

Effective and efficient data collection (D1-D8)		
Benchmark	**Common Problems**	**Solutions**
Complete and current asset inventory and condition data Efficient data collection and processing methods provide credible data at acceptable cost Information on customer perceptions collected and used	Data do not reflect full range of assets under agency responsibility Existing data lack credibility; data collection perceived as not worth its cost Information on customer perception of condition or performance is unavailable	Section 7.4 Cost Tracking Section 8.2 Information Needs and Data Quality

Information integration and access (D9-D13)		
Benchmark	**Common Problems**	**Solutions**
Managers at all levels can easily access information they need Maps of asset condition, need, and projects are readily available Geographic referencing and data standards in place	Lack of data sharing across units; duplication and inconsistency Staff lack good tools to access data or lack training on their use Lack of consistent geographic referencing	Section 8.3 Data Integration and Accessibility

Use of decision support tools (D14-D20)		
Benchmark	**Common Problems**	**Solutions**
Tools are available to calculate performance measures Tools are used to systematically identify needs and projects Tools are used to analyze project or strategy benefits and costs and compare alternate solutions	No systematic process for identifying needs Project selection lacks credible Justification Lack of ability to relate investment levels to resulting performance or benefit	Section 8.4 Decision Support

System monitoring and feedback (D21-D24)		
Benchmark	**Common Problems**	**Solutions**
Agency monitors system condition/performance Actual condition/performance compared to target values Information periodically provided to decision-makers and external stakeholders	No systematic process for monitoring capital programs No systematic process for monitoring maintenance programs No mechanism for providing monitoring results to decision-makers and external stakeholders	Section 7.3 Program Management Section 8.5 Systems Monitoring and Feedback Section 8.6 Reporting and Documentation

Support of asset management team initiatives (E1-E2)		
Benchmark	**Common Problems**	**Solutions**
AM implementation and Action Plan developed AM initiative fully funded for 3 yrs	Initiative can fail if not supported by Senior Mgt.	Decision makers must support the AM initiative with appropriate resources and commitment

Asset management team responsibilities (E3-E4)		
Benchmark	**Common Problems**	**Solutions**
Cross-asset analysis report delivered timely to be used in formulation of LRP	Little or no data analysis means little or no information from corporate data	Decide who should be responsible for AM repository and who should provide analysis

Funding allocations from x-asset optimization used from LRP to tactical/operational areas (E5-E6)		
Benchmark	**Common Problems**	**Solutions**
The LRP drives project selection at the tactical and operational levels. There is alignment from Strategic to Tactical to Operational programs.	Project selection is not in alignment with Strategic Goals and Measures	Education regarding the alignment process and the "strategic to tactical to operational" process

Asset management team coord. w/ management systems and tactical/operational areas (E7-E11)		
Benchmark	**Common Problems**	**Solutions**
DTIMS CT used for tactical and operational analysis for program delivery	Tactical and operational program delivery does not align with Strategic goals	Training, involvement and good communication required at all levels

Asset management team will share knowledge w/ other trans. agencies and local gov'ts (E12-E13)		
Benchmark	**Common Problems**	**Solutions**
More economical decisions made in all jurisdictions will provide a better transportation system for the existing funding	Inefficiency in project selection Competition for the same scarce resources	Training, involvement and good communication required with all highway jurisdictions

1) Throughout the survey, there is a very large gap between the perceived levels and desired levels of implementation, which means there is much education and work to be done.

2) There were a few of areas where there was a very low level of desired implementation among the majority of respondents, which can be improved with education and positive experiences.

3) Not only between each group, but also within each group there was a great variance among the existing levels and desired levels. The existing levels vary because of individual perceptions, which are caused by experiences and education. The correct answer will be arrived at as more individuals gain experience and education.

4) In general, areas that would cause a change of business within a respondent group resulted in lower support from that group.

5) Respondent groups should use their gap analysis and diagnostic charts in determining how to narrow all of the gaps and improve desired levels of implementation, paying special attention to the high priority areas as follows:

    a. Large Gaps. There were abnormally large gaps between existing and desired implementation in the following areas. The listed respondent groups are those that will need to improve education and work to **narrow the gap in these areas.**

        i. **Consideration of alternatives in planning and programming (B1-B3)**
            1. **All Groups**

        ii. **Information integration and access (D9-D13)**
            1. **All Groups**

        iii. **Use of decision support tools (D14-D20)**
            1. **All Groups**

        iv. **Use of decision support tools (D14-D20)**
            1. **All Groups**

        v. **System monitoring and feedback (D21-D24)**
            1. **All Groups**

b. Low Desire. There was an abnormally low level of desired implementation in the following areas. The listed respondent groups are those that will need to be educated and work to **improve desired implementation levels in these areas**.

   i. **Ensuring the proper state transportation network (B14-B15)**
      1. **Senior Management and Asset Groups**

   ii. **Asset management team responsibilities (E3-E4)**
      1. **Senior Management, Regions, and Asset Groups**

   iii. **Funding allocations from cross-asset optimization used from LRP to tactical and operational areas (E5-E6)**
      1. **All Groups**

   iv. **Asset management team coordination with management systems and tactical and operational areas (E7-E11)**
      1. **All Groups**

   v. **Asset management team will share knowledge with other transportation agencies and local governments (E12-E13)**
      1. **Senior Management, Regions, and Asset Groups**

7. Credits

1. This report uses many excerpts from the NHCRP Report 20-24(11) or “Asset Management Guide”. For example, the diagnostics section is mostly taken from the report, except for a few question groups that were added. The Utah Department of Transportation currently considers the “Asset Management Guide” as the guiding document for asset management implementation.

2. Kim Schvaneveldt and Glen Ames were the main authors of this report and they can be reached at the Utah Department of Transportation.

3. Jeffrey Zavitski of Deighton Associates Limited, contributed a great deal to this report, particularly Section 4.

8. Appendix

The appendix contains two sections:

1) Pages from NCHRP 20-24(11) for use with section 5.0
2) Asset Management System Implementation Assessment Survey

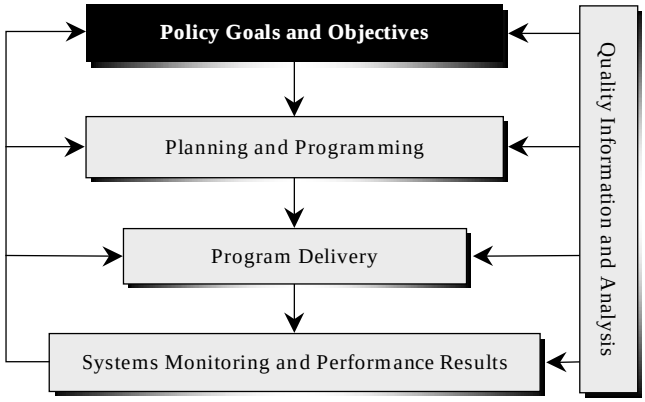
5. POLICY GOALS AND OBJECTIVES

5.1 INTRODUCTION

The resource allocation and utilization framework described in Chapter 2 represents a cyclic business process supported by systems monitoring, information, and feedback mechanisms. Interactions can occur throughout the process among these functions: e.g., between policy formulation and planning, and between planning and programming. Moreover, practices in these functions differ among DOTs. For clarity and organizational purposes in this ***Guide***, therefore, the stages of this framework are treated sequentially in individual chapters, recognizing that the actual business practices are more complicated.

In focusing on ***Policy Goals and Objectives***, this chapter looks at how asset management can improve policy formulation, the role of policy in driving other functions addressed by asset management (Figure 5.1), and the proactive role that your agency can play in policy formulation to advance asset management further.

Figure 5.1 Policy Goals and Objectives within Resource Allocation and Utilization



- **Section 5.2** describes the role of policy guidance in the context of the overall asset management framework;
- **Section 5.3** provides examples of improved policy development that can result from application of asset management principles;
- **Section 5.4** describes specifically how policy formulation is incorporated within a performance-based approach to infrastructure management; and
- **Section 5.5** describes proactive roles that a transportation agency can play with its external and internal stakeholders.

5.2 ROLE OF POLICY GUIDANCE

In the context of asset management, resource allocation and utilization in Figure 5.1 have a top-to-bottom consistency in the methods and criteria used for making decisions. The role of policy guidance in this context is to ***establish clear direction*** for the remaining functions. Planning, priority programming, program delivery, and system monitoring all need to be aligned with policy objectives and associated performance measures.

Policy guidance may be expressed in several ways that collectively define the directions and overall priorities for an agency's infrastructure management:

- State and federal statute or regulation;
- Policy statements and guidelines of the governor, legislature, and transportation commission or board;
- Directives issued by agency executives; and
- In some cases, agreements with other parties that define an agency role, responsibility, or target to be met.

The following items summarize key issues regarding policy formulation in an asset management context that will be dealt with in the remainder of this chapter:

- The importance of policy formulation, and of an agency's role in influencing how policies are formulated, can sometimes be overlooked.
- Policy guidance must be meaningful to all functions in resource allocation and utilization.
- The implications of policy statements should be explored by an agency, working with political leaders and stakeholders, during policy formulation rather than afterward.
- Policies should be related to objectives, performance measures, and performance targets right from the start.
- A customer perspective should be reflected in policy.

- A well-structured approach to policy formulation and adoption can help establish appropriate roles for the transportation agency and its governing bodies in subsequent program development and management.

5.3 IMPROVED POLICY-MAKING

The concepts and principles of asset management can improve the ways in which policies affecting transportation are conceived and formulated. This section will explore the following opportunities for improvement:

- Broadening thinking about potential transportation solutions;
- Relating "policy" to "process" more strongly; and
- Employing more analytic information in policy-making.

5.3.1 BROADENED THINKING

Asset management encourages the identification of options or alternatives at each stage of resource allocation and utilization. This broadened view of potential solutions to transportation needs can apply to policy formulation in the following ways:

- It encourages policy statements that focus on goals in terms of improved performance, rather than on the specific types of investments needed. For example, a policy goal may be to "reduce congestion." This goal can be met through a number of strategies such as investments in new capacity, operations projects to improve the efficiency of existing capacity, investments in other modes to divert excess demand, and spot improvements to relieve bottlenecks. Your agency should try to preserve its latitude to explore these options in long-range planning rather than at the policy formulation stage.
- If a policy-making body is intent on including proposed solutions as part of the policy statement (e.g., to explain the purpose of additional funding), it may be helpful to inform members of the several options available, and to try to encourage wording sufficiently broad to cover this range of possible solutions.
- Analyses of scenarios are being done increasingly in planning and programming; scenario testing can apply to policy formulation as well. "Scenario testing" in this context is the systematic investigation of the long-term costs to achieve different projected outcomes or results. It is a step in policy formulation that is often overlooked, but is critical to establishing realistic objectives and performance targets – or in setting the stage for additional resources. Increasing attention to the GASB 34 standards for the modified approach, which require disclosure of proposed values for asset condition and expenditures, also will encourage greater use of scenario testing.

These suggestions entail a proactive role for your agency in working with the legislature, governor's office, and transportation commission or board. It entails education, communication, and analytic support that leads to a greater shared understanding of the implications of particular policies. A by-product of this process is a more coherent set of policies, as will be discussed further below. Additional examples of how objective, analytic information can be usefully applied in policy formulation also are given below.

5.3.2 RELATING "POLICY" TO "PROCESS"

Policy formulation can sometimes appear detached from other agency functions. This situation is especially true if policy statements "say all the right things," but otherwise are not in a form that can be usefully applied to making judgments and decisions in infrastructure investments. Such policy statements may be too vague, numerous, or undifferentiated from one another to discern what are the tangible goals to be achieved and where are the priorities to be addressed.

Policy formulation in an asset management context "connects" directly to other functions in resource allocation and utilization. It leads to clear, specific, and preferably quantifiable targets for achievement in later stages of the process illustrated in Figure 5.1. If quantitative statements are not possible, qualitative statements can suffice if they are informative and meaningful (e.g., giving a sense of relative priority, or suggesting a measure of success). The mechanisms by which policy formulation can accomplish these purposes will be covered in Section 5.4, dealing with performance-based management. To have policy formulation fulfill this role of clear direction in asset management, however, your agency again must be proactive in working with policy-making bodies to

educate them on how performance-based management works, and what their roles are in the approach in relation to your agency's role (see Section 5.5.1).

Florida DOT Work Program Instructions

Each year, the Florida DOT's Program Development Office produces a set of "Work Program Instructions." The DOT's objective is to clearly communicate federal, legislative, gubernatorial, and DOT policies to the parties responsible for developing, adopting, and managing the DOT's work program. The document covers capital, maintenance, and operational activities. For example, the 2001 instructions include:

- *A matrix of legislative requirements that impact program development;*
- *The program development schedule and general instructions for developing, adopting, and managing the DOT's schedule of transportation projects (includes both capital and maintenance activities);*
- *Funding guidance, such as permitted use of federal and state funds, and program targets; and*
- *A discussion of alternative contracting mechanisms.*

This document is an example of the Florida DOT's efforts to tie policy to process. It can be found in its entirety at the following web site:

www11.myflorida.com/programdevelopmentoffice/work%20program%20instructions.htm

A benefit of relating policy to process is that the policies themselves become more coherent as a package – i.e., they give clearer direction collectively as well as individually. The reason for this greater consistency is that issues of relative priority of policy goals and expected outcomes are confronted during policy formulation rather than later; both your agency and your policy-making bodies can be on the same page regarding the purpose, importance, and expectations of your infrastructure investments. Moreover, this guidance can extend throughout your organization, providing the basis for clearer horizontal and vertical communication illustrated in Figure 2.2.

Connecting policy to process also can reduce the vulnerability created by the leadership turnover experienced by most transportation agencies every few years. Policy formulation that embodies the principles of transportation asset management (e.g., customer focus, performance-based, comprehensive view of assets, input from objective analytic tools, etc.) provides a framework for institutionalizing a correspondingly effective business process. Once ingrained as part of your agency's "way of doing business" and accepted by political bodies and other stakeholders, this method of policy formulation and the business processes that follow become easier to transmit to a succeeding administration.

5.3.3 Supporting Policy-Making with Objective Information

Objective information can assist policy-making in the following ways. First, current and projected information on transportation system condition and performance (including environmental, economic, social, and other impacts as available) can help identify trends and emerging situations requiring policy focus. Second, good information should inform policy formulation itself – i.e., policy objectives and targets should be set only after analyzing the costs to achieve different levels of condition and performance within a timeframe. Moreover, these scenarios need to be tested across the range of proposed policies, not just a single policy. (Relating policy to performance is discussed in more detail in Section 5.4.)

Analyzing the costs required to achieve and maintain various condition or performance levels would enable an agency to establish realistic targets (i.e., targets that are achievable given existing funding constraints, traffic usage, etc.). Such targets provide meaningful guidance for subsequent steps in the resource allocation and utilization process, and help to establish credibility with external stakeholders.

Many agencies now have the capability to conduct these types of scenario analyses at least for preservation, since modern pavement and bridge management systems often include a scenario testing capability. Maintenance management systems that are based on levels of service and performance budgeting also can develop these estimates for the maintenance program. Corresponding analyses in other areas (e.g., mobility, safety, economic development) may be available from long-range planning (Chapter 6). These tools can be employed in policy formulation as well as in planning and budgeting.

Executive Information Systems

One approach to providing policy-makers access to information is to create an executive information system (EIS). For example, the Washington State Transportation Executive Information System (TEIS) is a web-based tool designed to support legislative planning and oversight of transportation activities. Washington State Department of Transportation (WSDOT) managers and legislative transportation committees use the system to view executive-level information, perform queries, and generate reports. The TEIS consists of five components:

- *Fiscal and Performance Monitoring. This application is used to track all WSDOT expenditures, revenues, performance measure activities, and full-time employees*
- *Capital Projects and Facilities Reporting. This system is used by legislators, legislative committee members, and WSDOT staff to view the status of transportation-related capital projects. Information is available at both an individual project level and an aggregate level.*
- *Fund Balance and Fee Modeling. This application is used by legislative committee members to balance transportation fund forecasts and planned expenditures. With this component of the TEIS, users can view WSDOT's six-year program and financial plan and estimate income from proposed revenue sources.*
- *Transportation Resource Manual. This manual, which includes information regarding transportation finance, policy, and governance, is available online through the TEIS.*
- *Change Management System. This component is used to track suggestions for enhancements to any part of the TEIS.*

Further information is available on the TEIS web site: www.transinfo.state.wa.us/

5.3.4 How May These Steps Help?

The steps suggested above can help close gaps and overcome pitfalls in policy formulation in the following ways:

- They can improve the quality of policy guidance by encouraging consideration of alternatives, building a more coherent policy package, and applying good information and analytic support during policy formulation rather than afterwards.
- They can help overcome organizational impediments to more effective policy development. Seeing policy formulation as a stronger part of the resource allocation process and broadening the options and information technology support for policies can have several benefits:
  - It can encourage exploration of new options for transportation solutions and avoid an attitude of "business as usual."
  - It can combat the effects of turnover in leadership, establishing a core policy approach while recognizing that transitions between different policy perspectives are a fact of life.
  - It can build consensus among departmental units that would otherwise hold different perspectives on policies and agency priorities. It also can help to align internal organizational units that hold conflicting objectives.
  - It can encourage application of better information for use in current and future policy reviews.
- They can begin to address disconnects between current policies and existing decision criteria used in other functions shown in Figure 5.1. The exercise to define policy objectives and performance measures provides key elements by which to review procedures and criteria for decisions in planning, priority programming, and program delivery.

5.4 Relating Policy to Performance

5.4.1 Good Practice

Linking policy to performance is the foundation of the process in Figure 5.1. Good asset management in this context implies the following:

- Policy goals provide guidance on investment priorities and levels of performance.
- Policy goals are related to specific performance measures, which are consistent with the measures used in long-range planning, project evaluation, program tradeoffs, and system monitoring.
- Policies are evaluated with respect to the funding needed to attain particular levels of performance, prior to policy adoption.

- Policy formulation is revisited periodically or after major events affecting the policy framework (e.g., reauthorization of federal transportation legislation).

Preservation Policy and Asset Management

Preservation of existing assets is important to cost-effective management of existing infrastructure. It is for this reason that the management framework in Chapter 2 speaks to strategies that preserve existing infrastructure at least-life-cycle cost within available resources. These strategies can include both capital projects and maintenance activities. The framework also cites a benchmark practice to analyze capital-maintenance tradeoffs to determine the best overall strategy for preservation.

DOTs may be interested in a "preservation-first" policy, mindful of the value of their assets and the difficulty and expense of keeping these assets in good condition in the face of declining revenues. While the principles outlined in Chapter 2 certainly support cost-effective preservation, a "preservation-first" philosophy is a choice that is up to each DOT and its policy-making bodies.

Individual agencies and their policy-making bodies may adopt such a policy if they feel it is warranted. Asset management principles suggest that the merits of this policy be determined through a performance-based analysis of preservation versus competing needs of other programs, including scenario analyses of each program at different levels of investment and tradeoff analyses among programs. These analyses can help policy-makers determine whether a preservation-first policy should be adopted.

Policy formulation reflects public priorities regarding the role of transportation in a state. "Preservation of the existing system," "efficient and safe movement of people and goods," and "enabling growth and economic development" are ways of expressing different priorities. The asset management framework does not prescribe what priorities should come first – only that individual agencies and their policy-making bodies discuss and analyze policy options to adopt the ones that are felt to be warranted.

5.4.2 ELEMENTS OF THE APPROACH

Policies in a performance-based context can be developed with the following elements:

- ***Goals*** are statements that define the basic aim of a policy. Example policy goals are statements promoting better pavement performance and safety, respectively. ***Objectives*** are specific aspects of goals to be attained. For example, the objective for pavement performance may be "to provide road users with a smoother ride"; and for safety, "to reduce motor vehicle crashes."
- ***Performance measures*** are observable, quantifiable measures that align with objectives. They provide the way to track progress toward meeting the objectives. For example, measures of pavement ride quality or serviceability could be used to gauge smoothness of ride. A measure of crashes per 100 million vehicle-miles (100 MVM) could be used as the performance measure for the safety objective.
- ***Performance targets*** are specific values of performance measures that provide the level expected to be attained. This target may be set for a specific time period and with the understanding of a particular level of funding. It provides the bar against which actual performance data will be compared. For example:
  - Regarding pavement smoothness, the target may be to increase the percent of pavement network in good condition with respect to ride quality from 75 percent to 85 percent by the year 2005.
  - Regarding safety, the target may be to reduce the crash rate from 1.38 to 1.35 per 100 MVM by 2005.

This approach implies a "tighter fit" than may have existed in the past between policy formulation and the other functions in Figure 5.1. All of these functions employ performance measures in an asset management context. This "tighter fit" also is the reason for the suggestion that performance measures be defined at the time that policy goals and objectives are developed, as discussed in relation to the management framework that is illustrated in Figure 2.1. In this approach, performance measures provide the mechanism both for setting targets and for obtaining feedback on actual system performance.

In some situations policy-making bodies (particularly transportation boards or commissions) may participate in setting quantitative policy objectives, particularly if these objectives are being tied explicitly to additional funding. More typically, the policy statements that are adopted by policy-making bodies are qualitative, comprising goals and priorities. Transportation agencies

can then translate these statements into quantitative objectives, in consultation with their policy-making bodies.

5.4.3 Policy Guidance and Funding That Are Not Performance-Based

Policy guidance and associated funding apportionments may not always reflect a performance basis. For example, legislative funding decisions on programs for different assets, modes, or types of investments may be based on historical funding baselines, formula-based splits, or deal-making rather than current performance objectives or targets. (Refer to Section 5.5.1 for elaboration of these examples.) Institutional agreements with local or regional transportation organizations may result in agreed-upon funding splits that likewise may not reflect performance-based needs – or, if they are established with performance clearly in mind, are not reviewed and updated over time.

Situations such as these are realistically a fact of life. While they represent a different way of looking at transportation needs and priorities, they can nevertheless be made to work with performance-based methods. Some ways in which this can occur are as follows:

- To apply performance-based techniques within the existing policy framework or funding apportionment: i.e., to develop policy objectives, performance measures, and performance targets in the context of the existing political, institutional, and financial arrangements.
- To promote performance-based approaches with local and regional agencies that work with your DOT.
- To discuss transportation needs and priorities with other agencies to identify areas where strategic interests overlap, and to develop policy objectives and performance measures accounting for these.
- To conduct training, provide data support, and give other appropriate policy- and performance-related assistance to transportation agencies that provide services of state interest.

5.4.4 How May These Steps Help?

The steps suggested above can help close gaps and overcome pitfalls in policy formulation in the following ways:

- They provide a management structure and rationale to deal with broad, comprehensive, but vague policies (so-called "motherhood and apple pie" statements) that may enable agencies to gain widespread agreement, but do not provide concrete guidance for planning, programming, or budgeting. These statements need to be translated into policy objectives, together with definition of a consistent set of performance measures.
- They enable agencies to deal with policy guidance that does not reflect performance outcomes: e.g.,
  - Legislative or executive funding decisions that are not performance-driven;
  - Funding splits based purely on geography or history; or
  - Formula-based apportionments of funds that do not account for performance outcomes.

  Performance-based methods can be combined with the other criteria above to the degree that these other criteria cannot be changed directly.
- They provide a concrete basis to deal with internal guidelines or objectives that may not align with external policies. Again, policy objectives and target performance measures provide specific technical guidance that should be used to align internal guidelines in each affected department unit.

5.5 Playing a Proactive Role in Policy Formulation

Several situations described in previous sections call for active engagement by a transportation agency with policy-makers and other stakeholders. This section adds other examples to build a model of a proactive DOT role in policy formulation. The discussion is in two parts: one dealing with external policy-makers, the second with internal agency managers and staff.

5.5.1 EXTERNAL POLICY-MAKERS

Policy guidance can be issued in several ways. Previous sections discussed statutory and non-statutory policy statements at the state level provided by legislatures, the governor's office, and the transportation commission or board. Influences on policy also can originate with designated task forces, local and regional planning agencies, other transportation providers, and other bodies having political, administrative, fiscal, or regulatory oversight of a state DOT. A transportation agency needs to communicate with these groups to promote a policy framework that guides performance-based management, as described in earlier sections.

Legislative and executive priorities also can be expressed through funding decisions affecting specific asset classes or modes, program goals, or types of investments (e.g., preservation, system expansion or improvement, and operations). These decisions may not always follow the recommended program submitted by the DOT. For example:

- The legislature's decisions on funding transportation modes (e.g., highway, transit, bicycle and pedestrian ways) or assets (e.g., bridge seismic retrofit and pavement resurfacing) may result in amounts or schedules different from DOT recommendations.
- The governor's office or transportation commission may advocate funding for particular facilities (e.g., to support regional economic development); the legislature may include demonstration projects in the agency's budget likewise to achieve particular program goals.
- The legislature may fund particular highway programs in amounts or at a pace different from DOT recommendations, for experimental or demonstration purposes (e.g., to appropriate congestion relief funds among system expansion, system improvement, and system operations programs in specific ratios).

Texas DOT Briefing to Senate Interim Committee on Transportation

A Senate Interim Committee on Transportation was recently created in Texas and charged with, among other matters, reviewing the adequacy of the state's highway program and the financial resources supporting that program. The Texas Transportation Commission's testimony to the committee in 1998 is an example of proactively working with external policy-makers. The testimony emphasized long-term trends of factors such as traffic growth and safety, congestion levels and deteriorating road and bridge conditions. This information was presented as time-series data in concise graphics with clear messages. During presentation, this quantitative approach was complemented with anecdotes of specific instances designed to make the abstract data real.

The full testimony can be viewed in its entirety at: www.dot.state.tx.us/tdotnews/testimony/aug0498.htm

While funding decisions of this type are essentially expressions of policy, they also are decisions on resource allocation that are made outside a performance-based context. While legislative and executive authorities have this prerogative, DOTs need to deal with incorporating these decisions within an asset management framework that relies upon performance-based decisions. To the degree that designated programs, modes, asset classes, or investment categories are given statutory or funding priority, these areas of policy emphasis become a fixed part of an agency's asset management approach, and further decisions by the DOT must accommodate these policies.

The following sections outline strategies for an agency to focus policy-makers on policy guidance, and to reserve latitude for resource allocation decisions as much as possible to the DOT for deliberation during planning and priority programming.

ENGAGE EXTERNAL STAKEHOLDERS

Agencies ideally should engage their governing bodies whenever possible in discussions to frame and inform policy options. DOTs should communicate the implications of current asset conditions and current policies, and the costs and consequences of policy options. Regular briefings with policy-makers and dissemination of information to stakeholders and the public reinforce agency accountability for its decisions.

This engagement need not be limited to oral or written presentations. Agencies also can provide access to management systems for legislative, executive, and commission use. Executive Information Systems (EIS) that are based on the department's program management, financial, and technical data are excellent tools that can inform legislative, executive, and commission staffs regarding the department's programs and their status. (EIS are discussed further in Chapter 8.) Applications in maintenance quality assurance, based upon explicit levels of service and performance-based budgets, also have proven to be excellent tools for demonstrating the consequences of different levels of investment.

FOCUS ON KEY POLICY CHOICES

One potential benefit of asset management to DOT executives is to help avoid "external micromanagement" of programs during policy formulation. Asset management can be used to describe what responsibilities should be assumed by a policy-making body and by the transportation agency to have a policy-driven, performance-based approach work. It can be emphasized that policy-makers need to influence resource allocation at a strategic level. Tactical decisions on specific allocations will respond to these strategic directions (by meeting policy objectives), and the transportation agency is willing to be held accountable for these decisions (through performance measures). However, the specific decisions need to be examined in a number of dimensions (the asset management framework can be used to illustrate these), and the transportation agency needs to be staffed and equipped to carry out these analyses.

MAINTAIN A POLICY-BASED CONTEXT

An agency's engagement in policy development and its long-term perspective of asset management as a policy-driven process will help to maintain a policy-based context for resource allocation decisions. This continuity is needed through changes in political or agency executive leadership and during those periods when, in "the heat of the moment" as critical decisions are being deliberated, it is easy to lose sight of long-term objectives. An agency should continually reinforce and communicate the connection between long-term desired outcomes (as expressed in policy) and more immediate funding decisions (resource allocation) that is inherent in transportation asset management.

Policy direction may reflect other financial, institutional, and political considerations in addition to transportation system performance. This situation was discussed in Section 5.4.3, with practical suggestions on how to maintain a performance-based approach as much as possible.

5.5.2 INTERNAL STAKEHOLDERS

Internal stakeholders should be actively involved in the policy development process. Through their participation in this process, the units responsible for meeting policy objectives are more likely to understand DOT policies and support the subsequent objectives and targets. The involvement of front line workers from the very start of the policy-making process also may encourage them to begin considering a broader range of solutions to the issues they deal with on a daily basis.

The Benefits of Proactively Working with Legislators

Following is an example of one DOT's successful efforts to proactively work with policy-makers in two areas – system preservation and winter maintenance.

Preservation First

The DOT's key interaction with its legislature is through the legislative budget subcommittees that review and recommend approval of the agency's annual budget. Throughout the 1980s, the DOT worked with the subcommittees to establish the principle of "preservation first" – that preserving the existing system should have priority over creating new capacity.

The DOT's efforts were aided by the legislators' memories of the previous decade when the state had drifted away from this principle, with serious consequences for the condition of the highway network. However, it also was crucial to apply the principles of asset management (although it wasn't called that at the time) to present accurate life-cycle cost analysis that clearly demonstrated the economic benefits of the preservation priority. It also was important to consistently build this case year after year in a strategic context, rather than a one-time tactical approach to a particular budget.

The acid test for the preservation policy occurred in 1991, when a downturn in the economy and resulting curtailment of state revenues required the administration to stop advertising new projects at the peak of a major capital program. Many of these projects had been promised to the legislature and the general public as part of a transportation revenue program; deferral of these projects was thus a particularly sensitive issue. However, the general assembly had become advocates of the preservation-first philosophy, and the FY 1992/1993 budget reflected a 33 percent cut in capital programs and only a five percent reduction in maintenance.

Winter Maintenance

In the 1990s, the budget subcommittees questioned the DOT on whether contracting out additional winter maintenance services would result in cost savings. In responding to this inquiry, the DOT broadened the question into the larger issue of what was the appropriate level of the maintenance workforce, on the theory that winter maintenance requirements should be the primary basis for determining workforce size.

The DOT concluded that at least 50 percent of winter maintenance activity should be conducted by the maintenance workforce in dealing with an average peak storm (a snowfall of 6" – 8"), which suggested that a 10 percent cut in the size of the workforce could be accommodated. This analysis was based upon a combination of a quantitative review of snow clearance routes, a judgment as to what degree of presence was necessary to maintain operational control, and anecdotal evidence of the consequences of falling behind the curve in snow clearance in a major storm.

The budget subcommittees accepted this determination, and the workforce and winter maintenance policies were adjusted accordingly.

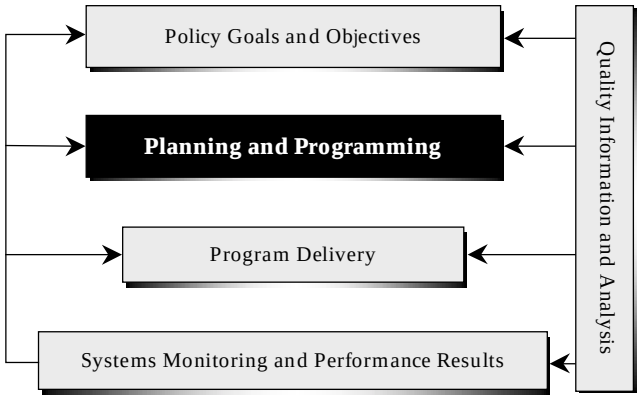
6. PLANNING AND PROGRAMMING

6.1 INTRODUCTION

Long-range transportation planning and priority programming are central to an agency's resource allocation decisions. This chapter discusses ***Planning and Programming*** as the second broadly defined stage in the asset management framework (Figure 6.1). It focuses on functions that lead up to program approval. Subsequent functions involved with program delivery are addressed in Chapter 7.

- **Section 6.2** discusses long-range planning in the context of asset management.
- **Section 6.3** is the first of three sections dealing with program development. It focuses on capital programming processes and tradeoff analyses.
- **Section 6.4** looks at the role of program structure and its effect on capital program development in an asset management framework.
- **Section 6.5** considers program development for maintenance and operations.

Figure 6.1 Planning and Programming within Resource Allocation and Utilization



State DOTs perform long-range planning and priority programming in accordance with ISTEA and TEA-21[1] requirements for the production of Long-Range Transportation Plans (LRTP) and Statewide Transportation Improvement Programs (STIP). The intent of this chapter is to illustrate how your agency's LRTP and STIP procedures can be strengthened from an asset-management perspective. It provides suggestions and examples of how planning and programming relate to the policy guidance described in Chapter 5, and how business processes and the program structure used in planning and programming are best organized for good asset management.

Your agency's existing procedures for developing the LRTP and the STIP are not "replaced by asset management"; the steps recommended in this chapter do not constitute another new or alternate process. The material in this chapter does not attempt to serve as a primer on planning and programming. The focus of this chapter is on how asset management ideas, principles, and techniques can shape your existing LRTP and STIP procedures, emphasizing capabilities such as the following:

- Applying procedures and decision criteria that are consistent with policy objectives and performance measures;
- Identifying alternative solutions at the planning and programming stages; and
- Having the information and analytic capabilities needed to evaluate alternatives and make resource allocation decisions that conform to good asset management practice.

6.2 LONG-RANGE PLANNING

A number of asset-management best practices apply to your long-range-planning process, regardless of whether your agency produces a "policy-based plan" or a "project-based plan." These benchmarks can be organized in three broad topic areas that are discussed in the sections below:

- Providing long-range guidance to agency resource allocation that is consistent with policy objectives;
- Identifying and evaluating strategic investment choices and analyzing tradeoffs between them; and
- Having the information and analytic tools available to conduct the analyses implied by a performance-based process.

6.2.1 CONSISTENCY WITH POLICY OBJECTIVES

The methods and criteria that are used in long-range planning need to reflect stated policy objectives and

[1] Intermodal Surface Transportation Efficiency Act, and Transportation Equity Act for the 21st Century.

performance measures. Inability to translate policies into performance targets can hinder an agency's ability to bring planning procedures into line with strategic priorities. A failure to achieve consistency with policy direction at the planning stage will likely have a ripple effect in subsequent stages of resource allocation. There are both strategic and tactical aspects to providing a coherent and systematic approach to resource allocation.

STRATEGIC CONSIDERATIONS

Strategic considerations deal with a meaningful translation of policy into action. They enable you to define investment options for consideration at the long-range planning stage that reflect and respond to strategic policy guidance.[2] In practical terms:

- Policy statements and other broad forms of policy guidance need to be translated into specific policy objectives, quantitatively to the extent possible. If this step has not been accomplished as part of your agency's review of transportation policy or in its strategic business planning, it needs to be completed at the start of long-range planning.
- Definitions of performance measures should accompany policy objectives that will guide transportation investments in each mode, program, major asset class, or other significant aspect of your transportation program. The selected measures should be able to reflect customer perceptions of system performance and quality of service where appropriate. Multiple measures may be needed to reflect different policies or to help understand what factors are driving changes in transportation trends. For example, measures reflecting both travel delay/congestion effects and impacts on economic development may be needed to assess investment options in mobility and accessibility. Performance measures should gauge outcomes in the transportation system rather than types of investments.[3] If performance measures have not already been defined in your agency's review of policy guidance or in its strategic business planning, they should be established at the start of long-range planning.
- Target values of performance measures should be established to guide the options to be considered in long-range planning. Performance targets should be realistic to avoid false expectations among external stakeholders and lack of sound direction to internal stakeholders. Targets should reflect realistic projections of revenues; scenario analyses of different revenue forecasts can provide useful guidance on the range of target values that can be attained with confidence. A continuing inability to meet targets and policy objectives can discredit your planning process and reduce the credibility of the LRTP itself if the plan cannot achieve the intended goals.
- Policy objectives and performance targets need to be tempered by other guidance that is not derived from performance-based considerations. This additional guidance, which was discussed in Sections 5.4.3 and 5.5.1, needs to be carried through the long-range-planning function as well (and into capital programming, as discussed in Section 6.3). The effect of this guidance can be accounted for in an adjustment in policy objectives and targets among programs or districts, or it may influence the type and expense of investments considered in different parts of a program.

TACTICAL CONSIDERATIONS

Tactical considerations deal with more specific issues in translating policy into action:

- In setting performance targets for particular assets, modes, corridors, programs, etc., your agency also should account for sources that provide specific guidance (e.g., in the form of recommended standards or levels of development) or explore different strategies for investment. Level-of-development plans, corridor plans, corridor preservation plans, access plans, special studies (e.g., of future transportation strategies or of long-term needs) and similar documents are examples of sources of guidance that may be focused on particular subsets of the transportation network. It also is important that all levels of your agency – field planning offices as well as central office staff – be aware of these studies

[2] Please review Section 5.3.2 on translating policy into process, and Section 5.4 on relating policy to performance, if you have not already done so.

[3] Refer to discussion of this point in Section 5.3.1.

and understand how they are to be used in the planning process.

Program Investment Categories

Colorado DOT has defined Program Investment Categories to facilitate a performance-based environment for its planning and programming activities. Its Program Investment Categories include:

- *Strategic Projects;*
- *Mobility;*
- *System Quality;*
- *Safety; and*
- *Program Delivery.*

Important characteristics of these Investment Categories are the following:

- *The Investment Categories overlay the conventional program structure; they do not replace the programs used for funding and tracking accomplishment by different organizational units.*
- *The Investment Categories map directly to transportation policy goals and performance measures.*
- *Investment Categories include projected funding from both capital construction programs and maintenance and operations programs.*
- *Conventional program funds are applied in the Investment Category structure according to primary policy objective served. For example, preservation activities in Maintenance and Operations map to System Quality; sign and striping activities in Maintenance and Operations map to Safety; and snow removal performed by Maintenance and Operations maps to Mobility.*
- *Investment Categories help CDOT to see what funding is available to meet strategic policy goals and to relate investment levels to performance measures, regardless of program funding source. The Investment Category structure also is suitable to be applied in the future to tradeoff analyses.*

- Existing policies may call for environmental reviews or other long-lead-time assessments of project characteristics. Criteria and procedures should be established to determine when these reviews or assessments need to begin in the planning stage.
- The results of the planning stage should inform project identification during priority programming. The nature of this guidance should be agreed to by the planning and the capital programming units within your agency, so that a consistent thread is maintained throughout these stages of resource allocation.

6.2.2 ALTERNATIVES AND TRADEOFFS

Investment alternatives are appropriately defined in long-range planning as well as in priority programming. Options at the planning stage may involve a number of different choices as illustrated below. The specific options that you may need to consider will depend upon the structure of your agency's programs and its responsibilities for different modes and infrastructure assets, the characteristics of your transportation system, and the areas of emphasis in current policy objectives. Potential options in planning include the following:

- **Modal Options**. Choices between modes may be direct and obvious when both modes fall under the responsibility of your DOT. Defining alternatives becomes more complicated when the solution is an indirect one (e.g., highway congestion will be relieved by an improvement to a parallel rail line or transit line), where service providers other than the DOT are involved, and where funding eligibility guidelines may preclude consideration of this option. Engaging policy-makers, service providers, and other stakeholders can identify options that might be available.
- **Program Investment Options**. With increasing demands on transportation programs and funding, alternatives in the types of investments may offer an option to meet transportation needs more quickly and economically. In the mobility area, for example, investments in operations improvements may defer the need to undertake new construction for capacity expansion. In the preservation area, preventive maintenance strategies can reduce the long-term cost of keeping facilities in good condition as compared to capital-intensive, worst-first approaches.
- **Other Options**. Other ways of visualizing options include corridor alternatives (already familiar to transportation planners), staged implementation strategies, technological options (e.g., use of innovative materials and procedures for preservation, or ITS technologies for traffic

management), and combinations of all of the above.

Multimodal Trust Funds

The use of multimodal trust funds can provide agencies the flexibility to meet varying transportation service and infrastructure needs. For example, in the early 1970s one DOT established an integrated trust fund to support all of its activities, which include modal agency operations, capital construction projects, and debt service expenses for highways, transit, ports, airports, railroads, and motor vehicles.

This fund consists of motor fuel taxes, motor vehicle excise (titling) taxes, motor vehicle fees (registrations, licenses, and other fees), corporate income taxes, operating revenues (e.g., airport fees, transit fares, port fees), federal aid, and bond proceeds. Bonds are issued to support the cash flow requirements of the planned capital program while maintaining coverage requirements.

These revenues are not earmarked for specific programs. The disbursement of funds to projects and programs is made in conjunction with state- and local-elected officials and is not constrained by the source of revenues. Unexpended funds at the close of the fiscal year do not revert to the state's General Fund, but remain in the Trust Fund.

This financing structure encourages optimization of the transportation system without regard to modal bias. As a result, the agency has been in a position to analyze and pursue modal tradeoffs and intermodal opportunities. One illustration is an aggressive program to provide direct-access connections from the freeway network to suburban rail stations with large parking lots. A common funding source and a strategic, customer-focused approach to asset management has enabled these projects to avoid the institutional rivalries that often handicap such intermodal proposals.

Options should be given due consideration appropriate to their importance and cost, avoiding too early a focus on a single solution. Failing to consider feasible options across programs, modes, or other dimensions may lead to missed opportunities and less than "optimal" LRTPs. Support information that may be needed to evaluate options effectively (e.g., early "scoping" studies to evaluate technical, economic, and financial feasibility, or environmental reviews of potentially complex projects) may need to be developed at an early planning stage.

Options can address needs at a project, corridor, or "major project" level (e.g., a project of statewide interest that may comprise multiple network segments from different but related corridors). Evaluations of these options should be "apples to apples" – that is, project alternatives compared to each other, corridor alternatives compared to each other, and so forth.

Options need to be evaluated against one another in a planning-level tradeoff analysis. One of the main considerations in planning-level tradeoffs is the availability of analytic tools; this issue will be discussed in the next section. In the context of this discussion, tradeoffs should identify the comparative costs, benefits, and performance impacts of different options in a life-cycle context. The tradeoff results should indicate the relative strengths and weaknesses of each option, and which option overall presents the best balance of characteristics for your agency. A tradeoff analysis also may suggest other options for investigation.

6.2.3 Information and Analytic Methods

Good information in long-range planning can assist in a number of ways to support good asset management practice:

- Performance targets need to be realistic both technically and financially, based upon realistic forecasts of revenue. Unrealistic performance targets can call into question the long-range-planning process and its products.
- Estimates of costs, benefits, and performance used in the analyses of options and tradeoffs should reflect realistic technical, economic, financial, and environmental characteristics. Lack of good information in these estimates can limit the effectiveness of planning in evaluating the relative merits of different options and in the guidance given to priority programming. Existing applications such as management systems (e.g., PMS, BMS) and other analytic procedures (e.g., network models, economic impact models) can assist in these estimates.
- Criteria for early scoping, environmental reviews, and other pre-engineering studies that may need to begin during planning (e.g., for major, complex, long-lead-time projects) can clarify information needs at various timeframes in the 20-year planning horizon and focus the application of different analytic tools properly.

Analytic tools and well-organized data collection and processing techniques could assist in providing the

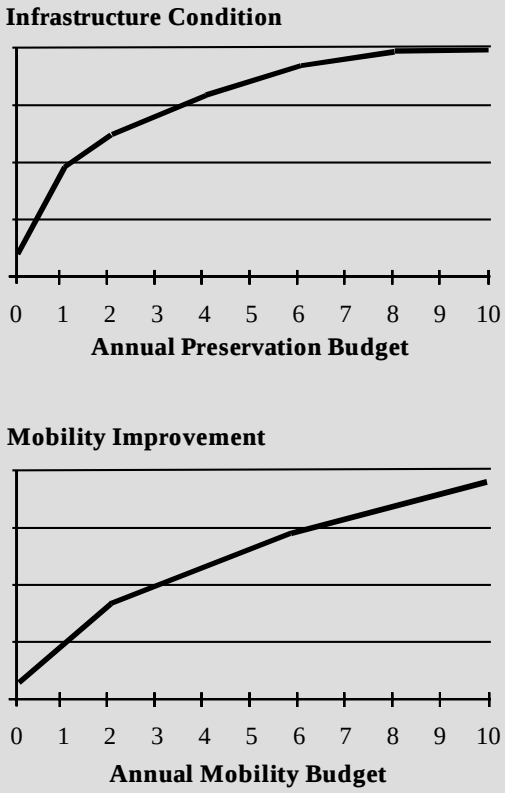
information needed to evaluate performance targets as well as planning options. While DOT planning organizations already apply IT applications to evaluate travel demand and the network impacts of different proposed investments, tools to consider a broader set of options, performance impacts, and tradeoffs – for example, in a multimodal context – are still in a state of development, and data quality remains an issue as well. A number of current efforts promise improvement in the state-of-practice in the future:

- Development of sketch planning tools that enable an analysis of options that is relatively quick, inexpensive, and not too data-intensive.
- Application of FHWA's HERS/ST system to look at preservation versus improvement tradeoffs.
- Work in NCHRP Project 8-32A to develop a methodology for structuring and evaluating multimodal tradeoffs at the planning stage.
- New analytic procedures and recommended approaches may emerge from the ongoing NCHRP Project 20-57 that is looking at analytic tools that support asset management.

Tradeoff Analysis

Figure 6.2 illustrates information that can be used for a tradeoff analysis in long-range planning. The analysis considers the impact of varying the funding levels in two programs: Preservation and Improvement. The upper graph shows the impact of different Preservation budget levels on forecast infrastructure condition; the lower graph shows the impact of different Improvement budget levels on forecast mobility improvements. These graphs can help an agency understand the implications of different investment options, frame planning-level tradeoffs, and illustrate the consequences of planning-level decisions. While the example is developed for two programs, other programs, as well as more detailed breakdowns of the programs shown, can be considered in the tradeoff process. Management systems, other analytic tools, and analyses of performance impacts of similar investments can assist in obtaining these estimates.

Figure 6.2 Example of Information for Use in a Planning Tradeoff Analysis



At a minimum, there is benefit to be gained from structuring existing information in a way that informs tradeoffs: i.e., by organizing information based upon a baseline analysis and scenarios representing different performance targets or investment options. Scenario-testing capabilities, if available in existing systems, should be used to populate this matrix. If such capabilities are not available as a feature, it may be possible to use existing applications to test scenarios indirectly – for example, by exercising these systems repetitively while varying boundary conditions (such as engineering threshold values or financial budget constraints) in each run to assess system behavior and performance impacts under different conditions.

6.2.4 How May These Steps Help?

The recommendations in the preceding sections are intended to help your agency instill in its long-range planning a number of asset-management best practices:

- Planning efforts reflect stated policy objectives and performance expectations.
- A range of investment options (e.g., capital, maintenance, and operations) and modal alternatives are considered during the planning process, with an analysis of tradeoffs among these choices.
- The LRTP is based on realistic revenue forecasts and evaluation of new funding options or levels of funding where appropriate.
- The planning process provides clear guidance for subsequent program development (e.g., project identification, ranking, and selection).
- The planning process is supported by management systems, "sketch planning" tools, and other analytic procedures that help analyze options and scenarios in terms of cost and performance.

6.3 Capital Programming Process

6.3.1 Overall Context of Program Development

Program development is the stage of resource allocation that recommends specific investment actions, whether for capital construction projects, preventive or corrective maintenance activities, or maintenance and operations services. Asset management speaks to several aspects of program development. This is particularly true for capital construction programming[4], which typically accounts for a major portion of a state DOT's annual budget, and corresponds to the production of its STIP.

The discussion of this critical function and other aspects of program development is therefore organized in the ***Guide*** as follows:

- Section 6.3 focuses on the capital programming process, and how asset management concepts and principles apply to identification and selection of projects for infrastructure preservation, expansion, operations, and safety.
- Section 6.4 also focuses on capital programming, but from the perspective of the program structure and how different organizations of programs and categories of work can influence the ease and effectiveness with which you can apply asset management techniques.
- Section 6.5 discusses program development for maintenance and operations work, dealing with delivery of services as opposed to construction projects. Current concepts of maintenance quality assurance and performance-based budgeting are highly relevant to asset management, and are covered in this section.

6.3.2 Capital Programming Best Practices

Best practices in capital programming follow many of the themes outlined in policy formulation and long-range planning:

- Policy objectives are explicitly represented in methods and criteria applied in capital programming:
  - Project identification, scoping, prioritization, and selection criteria;
  - System performance measures, and predictions of the impacts of candidate project investments on these performance measures;

[4] Priority programming is also used synonymously in this ***Guide***.

  - Program tradeoff criteria; and
  - Periodic updates of programming process to reflect and reinforce changes in policy.

- The programming process considers alternative project solutions to transportation needs, problems, and deficiencies, consistent with program objectives and guidance from the LRTP. Examples include the following:
  - Solutions representing different types of investments: e.g., operations versus capacity improvements to congested segments; repair versus rehabilitation or reconstruction;
  - Different project concepts, designs; or technologies; and
  - Different strategies for staging work over time.
- Economic principles are applied to the analysis of project worth. At the heart of each analysis is a comparison of benefits and costs on a life-cycle basis and, where applicable, minimization of long-term costs. Cost/benefit calculations incorporate performance measures within a performance-based budgeting framework.
- While the economic criterion is important, it is not the sole basis for selecting projects. Other factors also may be considered: e.g., environmental protection, intermodal service, network connectivity, neighborhood cohesion, preservation of corridor standards, and economic necessity.
- Project selection is based on realistic project scopes, costs, and schedules. Accurate estimates ensure that project prioritization is based on reliable gauges of project merit, and reduce the likelihood of subsequent project changes that may result in "non-optimal" adjustments to programs.
- The programming process considers alternative solutions also at the program level in terms of tradeoffs analyzing potential shifts in funding among programs and their implications for overall transportation system performance.
- Quality information and analytical tools are applied throughout the programming process. An agency has the capability to project realistic estimates of costs, benefits, and impacts on system performance using management systems, other analytic tools, activity-based approaches to cost recording, and performance budgeting tools.

Washington State Life-Cycle Techniques

In 1993, state legislation RCW 47.05 mandated revisions to the Washington State DOT's programming process. This legislation required the agency to prioritize projects based upon rational methods, considering factual needs and an evaluation of life-cycle benefits and costs. In response, WSDOT developed a programming process based on project prioritization using benefit/cost criteria. WSDOT applied its existing pavement management system to analyze least-life-cycle-cost strategies for pavement preservation. In other program areas it formed task forces to develop evaluation procedures based upon engineering and economic criteria appropriate to each type of project work considered. These analytic procedures are now used to develop benefit-cost estimates for project prioritization.

For further information, RCW 47.05 is available on the following web site:

search.leg.wa.gov/pub/textsearch/ViewRoot.asp?Action=Html&Item=7&X=726112422&p=1

The "Washington State DOT Programming and Operations Manual" is available at:

www.wsdot.wa.gov/FASC/EngineeringPublications/Manuals/P_OManual.pdf

6.3.3 EXAMPLE PROCESS INCORPORATING BEST PRACTICES

The best practices described in the preceding section can be incorporated within your existing capital programming and STIP development framework. The following example process comprises a cycle of program development steps that reflects the best practices above. This process is not meant to be prescriptive or exhaustive, and your existing process may have a different sequence of steps or reflect a different approach.[5] This example is included only to show how program development can be organized in an asset management framework, illustrating both project-level and program-level decisions. The steps are presented in sequential fashion for simplicity; however, iterations of individual steps may occur in

[5] For example, certain DOTs allocate funding to districts for programs based on policy and system performance rather than projects, as illustrated in the example given. Thus, a range of programming approaches are possible. The principles of asset management should nevertheless apply across this range.

practice. Your agency can adapt this example to your own capital programming and STIP development process in considering asset management best practices.

1. **Issue program guidance and instructions**. Program guidance contains a summary of policy goals and objectives and their implications for financial and performance targets. Program instructions contain financial, accounting, and administrative details that need to be adhered to in the current programming cycle.

2. **Nominate and submit candidate projects**. Nominations are typically submitted by program managers, district engineers, and other designated managers on behalf of stakeholders.

- Project submittals are guided by the LRTP and by other relevant studies (e.g., analyses of preservation strategies in pavement or bridge management; corridor studies or special planning studies).
- Nominations are conducted in a formal process using forms that provide, at a minimum, the description of proposed work and its justification, proposed funding source, estimated cost, calculated impact on performance, local support, and special considerations.
- The preferred measures of performance impacts are 1) technical performance measure(s) that are associated with the respective program and are responsive to policy objectives, and 2) translation of technical impacts into an economic benefit if possible. Advantages of a monetary measure of benefits are that:
  - They can be used in benefit/cost calculations as part of project prioritization;
  - Dollar benefits are additive (meaning that they can be summed for all projects to obtain a program-level indicator useful in tradeoff analyses); and
  - They are commensurate with dollar benefits calculated for other programs (even if the technical performance measures are different), facilitating tradeoff analyses further.

3. **Candidate projects are reviewed with district engineers and program managers.** These reviews are conducted in meetings held by the management team responsible for building the capital program. Items to be reviewed include:

- Realism of estimates of costs, benefits, and other impacts;
- Appropriateness of the project for the route's Level of Development Plan and consistency with relevant preservation, corridor, or other special studies;
- Eligibility for indicated program funding;
- Conformity with guidelines and instructions;
- Degree of local support; and
- Suggested revisions.

As part of these discussions, district and program managers can be asked what their responses would be to shifts in funding for the program being reviewed: i.e., if some percentage change in funding occurred at the margin, either positive or negative, what additional work would they recommend, or what proposed projects would need to be cut or reduced in scope? These discussions provide background information for the tradeoff analyses later.

4. **Projects are scoped and prioritized.** Prioritization methods and criteria should reflect a performance basis, consistent with policy objectives and performance measures as updated in the current LRTP. Prioritization will result in a list of ranked projects that are reviewed and may be adjusted as follows:

- A preliminary "cutoff" is set on the ranked list of projects based upon preliminary funding targets for each program. This constrained list defines a preliminary, baseline, or candidate program.
- Managers may adjust the prioritized list where justified to reflect considerations such as network continuity, local commitments, or factors that are not accounted for in the prioritization criteria. Such adjustments and their justification should be documented.
- The ranked project list may need to conform to geographic equity criteria, which may require further adjustments in the prioritized list and should be documented as such. (See Section 6.3.5 for a discussion of geographic equity.)

Project priorities should not be taken as literal numerical values (i.e., in the sense that "project number 17 is better than project number 21"), but rather as

a way of grouping projects into sets: e.g., highly ranked projects that will be performed in any foreseeable scenario, mid-range projects that are worthwhile and have a good chance of funding, and lower-ranked projects that have merit but for which approval will be sensitive to the results of a tradeoff analysis.

If, subsequently, there are major changes in project scope, cost, or schedule, the project should be reprioritized (discussed below).

5. **Conduct tradeoff analyses between programs.** The purpose of a tradeoff analysis is to assess whether preliminary program funding targets should be adjusted based upon the cost and performance impacts indicated in the tradeoff. It is a way to consider options (in terms of financial targets) at a program, rather than a project, level. An example of the mechanism of tradeoff analyses will be given in Section 6.3.4. Tradeoffs do not have to be conducted among all possible combinations of programs, but rather only where it makes sense to consider potential shifts in funding from one program to another. Tradeoff analyses between programs should be conducted only after the projects within those programs have been prioritized and a preliminary financial target (or cutoff) has been established.

While management systems and other analytic tools can be used to estimate the performance impacts of different alternatives, ultimately the judgment regarding program tradeoffs is a managerial one in which policy objectives must be weighed as a guide to the final decision. Where program tradeoffs are indicated and a shift in program funding is likely, the question of geographic equity may need to be revisited, and adjustments in the proposed funding shift made accordingly.

6. **Finalize program funding targets based upon the tradeoff analyses.** The cumulative set of analyses and adjustments in the preceding step result in a revised funding distribution that can now be finalized. Results of the tradeoff analyses and judgments based on these results should be documented for possible later use in discussions with the Transportation Board and Legislature to justify the recommended program.

Unless there are any further adjustments, this final funding distribution can be submitted, with the adjusted list of prioritized projects in each subprogram, as the recommended capital construction program. If last-minute adjustments do occur:

- Tradeoff analyses would need to be repeated only if there are major changes in specific projects that are included in the recommended program, or in the information regarding particular projects (e.g., costs, benefits, performance impacts).
- If the situation above occurs, the tradeoff analysis should be preceded by a re-estimate of costs, benefits, and performance impacts of affected projects and a re-prioritization of projects in the affected program.

7. **Conclude this programming cycle and prepare for the next cycle.** Concluding activities entail submittal of the recommended program, distribution of the program to stakeholders as appropriate, and any associated updates to program tracking databases. Preparations for the next cycle include updates to the program guidance and instructions, based upon experience of the just-completed exercise.

6.3.4 TRADEOFF ANALYSES

Tradeoff analyses are ways to consider alternative resource allocations at a program level, as compared to the project-to-project evaluations that result from project prioritization. Table 6.1 illustrates the types of tradeoffs that can be considered between different combinations of program investments. Results of an example tradeoff analysis are illustrated in Table 6.2 for Preservation and Improvement. The analysis involves testing what are the consequences of shifting funding from one program to another, and making a judgment as to which resource allocation option is the most favorable. Consequences are gauged by resulting changes in performance measures. The performance measures in Table 6.2 are generalized for purposes of the example; in an actual analysis, it may be helpful to compute one or more performance measures for each subprogram considered (e.g., in Preservation, to consider separate performance measures for pavement, structures, and other features; and for Improvement, to consider measures related to mobility, accessibility, safety, and so forth). For the analysis to work, performance measures must be able to be expressed at a program as well as a project level: i.e., they must be additive (e.g., measures of user costs or benefits that result from economic analyses of projects) or be able to be rolled up as an average or other composite measure (e.g., percentage of facilities that meet a threshold value). An agency's management systems (such as PMS and BMS) can contribute to

tradeoff analyses through their scenario-testing capabilities. Tools such as the FHWA's HERS/ST can assist in tradeoff analyses across programs, since HERS/ST handles both pavement- and capacity-related investments. Analytic tools for subprograms not addressed by existing systems can be developed in simple formats (e.g., as spreadsheet workbooks or database applications) to provide a near-term capability for tradeoff analyses.

Table 6.2 shows two tradeoff cycles for illustration; any number may be conducted as determined by managers in light of results already obtained and whether it is worthwhile to explore additional options. The examples in Table 6.2 show shifts of funds in both directions; other options could investigate different magnitudes of a funding shift. While the analysis shown assumes that total funding remains fixed, this type of analysis also can be used to investigate the consequences of changed levels of funding, whether positive or negative.

Preservation versus Improvement Tradeoffs

The FHWA's Highway Economic Requirements System (HERS) is an example of a tool that supports tradeoffs between preservation and improvement projects. A state version, HERS/ST, is now being promoted. The HERS application is based on the Highway Performance Monitoring System (HPMS) database, and is intended to replace HPMS as the source of biennial federal needs studies submitted to Congress. The HERS algorithms address both highway capacity and pavement preservation needs. Thus, HERS/ST is uniquely suited to asset management studies that are more comprehensive than those addressed by individual management systems (e.g., pavement management and congestion management). For example, HERS/ST could be applied to explore tradeoffs between system preservation and system improvement or expansion.

Table 6.1 Examples of Potential Tradeoffs between Types of Program Investments

	Capital Preservation and Maintenance	System Improvement and Expansion	System Operations
Capital Preservation and Maintenance	➢ Capital-maintenance tradeoffs ➢ Worst-first verses preventive strategies	–	–
System Improvement and Expansion	➢ Tradeoffs between preservation and capacity	➢ Major versus minor capacity and safety improvements	–
System Operations	➢ Tradeoffs among methods of incident response and motorist warnings	➢ Tradeoffs between roadway and technology approaches	➢ Degree of system coordination in corridors and network

6.3.5 GEOGRAPHIC EQUITY

Geographic-based, or "equity-based," funding distributions exist in many agencies and are a political fact of life. The rationale for such distributions may come from several sources:

- Agreements on funding splits with regional and local agencies;
- "Hold harmless" arrangements with regions or districts of a DOT;
- Responses to environmental justice issues regarding the equitable distribution of transportation services to different segments of the population;
- Legislative or transportation board/commission desires for equity statewide; and
- Historical, formula-based arrangements.

Capital-Maintenance Tradeoffs for Pavements

Specialized pavement analysis tools can analyze capital-maintenance tradeoffs and preventive, corrective, and deferred maintenance and rehabilitation strategies as they apply to pavements. The FHWA's EAROMAR system is one such tool. The system is used by the FHWA to conduct pavement life-cycle cost analyses on high-standard roads. EAROMAR has engineering and economic relationships to analyze different types of pavement maintenance, rehabilitation, and reconstruction options and their impacts on both agency costs and user costs. Because it employs a detailed analysis of work zones and their effects on traffic flow and congestion, it also can be used to investigate the staging of projects and the effects of construction or maintenance work packaging, as well as options to limit road occupancy to particular hours of the day or to particular months or seasons of the year.

Reference for additional information: Markow, M.J., and B.D. Brademeyer, ***EAROMAR Version 2, Final Technical Report****, FHWA/RD-82/086, April 1984.*

While geographic distributions and performance-based concepts are different ways of looking at resource allocation, they can be made to work together in a manner that is still consistent with a performance-based approach in asset management. The recommended approach is to maintain a performance-based context for resource allocation and utilization as much as possible, but to acknowledge and articulate the geographic distributions explicitly rather than to "bury" or rationalize them.

Examples of ways to accommodate geographic equity within a performance-based context are as follows:

- Apply a "dual" or "hybrid" method of resource allocation by program. For example, a percentage of funds may be allocated to districts on a geographic basis for district-level prioritization; the remaining program funds may be allocated based upon statewide competition among projects. The district percentages may vary by program.
- Apply performance-based evaluation methods within geographic allocations. While the overall funding split may be geographically based, the evaluation of projects within programs will be according to policy objectives, performance measures, and associated criteria.
- Use selected performance indicators as surrogates for geographic allocation. For example, measures of traffic volume or user benefits could be used in lieu of geographic percentage allocations. The methodology would need to be designed, however, to ensure that rural projects could compete with urban projects fairly (e.g., by calculating an incremental benefit/cost return rather than looking simply at total magnitudes of benefits).

Table 6.2 Illustration of a Tradeoff Analysis

	Proposed Preservation Funding and *Resulting Performance*	**Proposed Improvement Funding and *Resulting Performance***
Baseline	$200 million *80% of facilities rated Good*	$500 million *10% reduction in travel time costs*
First Tradeoff Analysis	($200M less $15M) = $185 million *77% of facilities rated Good*	($500M plus $15M) = $515 million *11% reduction in travel time costs*
Second Tradeoff Analysis	($200M plus $15M) = $215 million *82% of facilities rated Good*	($500M less $15M) = $485 million *8% reduction in travel time costs*

6.4 PROGRAM STRUCTURE AND DEFINITION

The effectiveness of resource allocation can be influenced by the structure of the capital program itself. Typical pitfalls that can arise include the following:

- Programs and subprograms may be too numerous and detailed to clearly see the implications of choices and decisions.
- Programs and subprograms that represent too fine a breakdown of work, overlapping definitions, or outdated transportation needs can distort the resource allocation process, since zero-funding a program is rarely seen as an option, and non-optimal allocations may result.
- Inconsistent methods of defining programs can obscure the linkage between resource allocation decisions and support of policy objectives.

The first two issues relate to program structure and its relative simplicity. The third issue is one of consistent definition.

6.4.1 STREAMLINING PROGRAM STRUCTURE

Flexibility and latitude in resource allocation are increased when the program structure is "streamlined" to focus on key outcomes, however defined (Section 6.4.2). A "streamlined" program structure in this context implies a "pyramid" structure in which high-level programs and subprograms are as few in number and as broad in scope as practicable to manage the capital program effectively. Identification of specific types or categories of work at the lowest level can be as detailed as needed for financial management and accounting; it is the higher-level structure of programs and subprograms that is critical to resource allocation and tradeoff analyses.

Consider the examples presented in Figures 6.3 and 6.4. Assume that Figure 6.3 represents a DOT's current program structure. For clarity, a single program within a capital program structure is shown; in fact, multiple programs will typically exist (e.g., preservation, improvement, safety). Figure 6.4 recommends a new more streamlined program structure for the DOT. Since both structures encompass the same categories of work, shown at the bottom in both figures, they are both capable of addressing the same pool of projects. However, the new structure in Figure 6.4 has fewer subprograms than Figure 6.3, creating different relationships among programs, subprograms, and categories of work. To generalize: Figure 6.4 represents more of a pyramid structure with fewer subprograms but with each subprogram more broadly defined, encompassing multiple categories of work. Figure 6.3 shows a flatter structure in which there are a greater number of subprograms, each more specialized in a narrower category of work.

Figure 6.4 represents a more streamlined program structure that can help in resource allocation. Since this structure does not restrict managers to a narrow category of work within a subprogram, it facilitates their consideration of alternative solutions in each case. It also affords managers greater opportunity to consider resource allocations between multiple categories of work within each subprogram. It enables managers to consider tradeoffs between broadly defined subprograms, clarifying decisions among critical policy choices. While the examples in Figures 6.3 and 6.4 center on subprograms, the same ideas hold for programs within the overall capital program structure.

This comparison should not be misconstrued as arguing against needed distinctions in types of work at the subprogram (or even the program) level. All it implies is that details regarding the many possible types of capital projects should not be pushed up too high in the program structure so as to impede definition of alternatives, tradeoff analyses, and relating investment decisions to broad policy objectives. To cite a couple practical implications of this thought:

- A preservation program could include individual subprograms for pavements and structures, without detracting from resource allocation decisions and estimates of performance impacts. However, treating distinctions between, say, rigid and flexible pavement projects, or Superpave versus conventional pavement projects, at too high a level in the program structure dilutes the impact of pavement investments and complicates tracking of pavement performance as a function of resource allocation decisions.

Figure 6.3 Original Program Structure

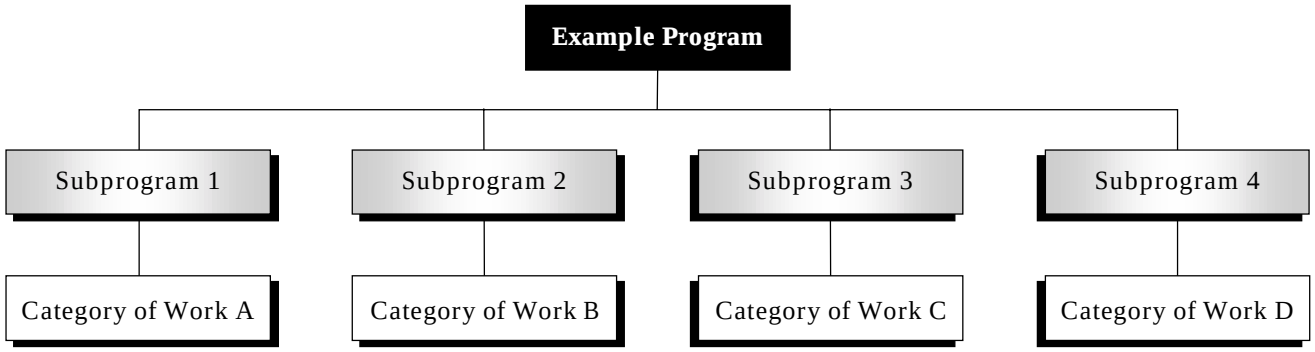
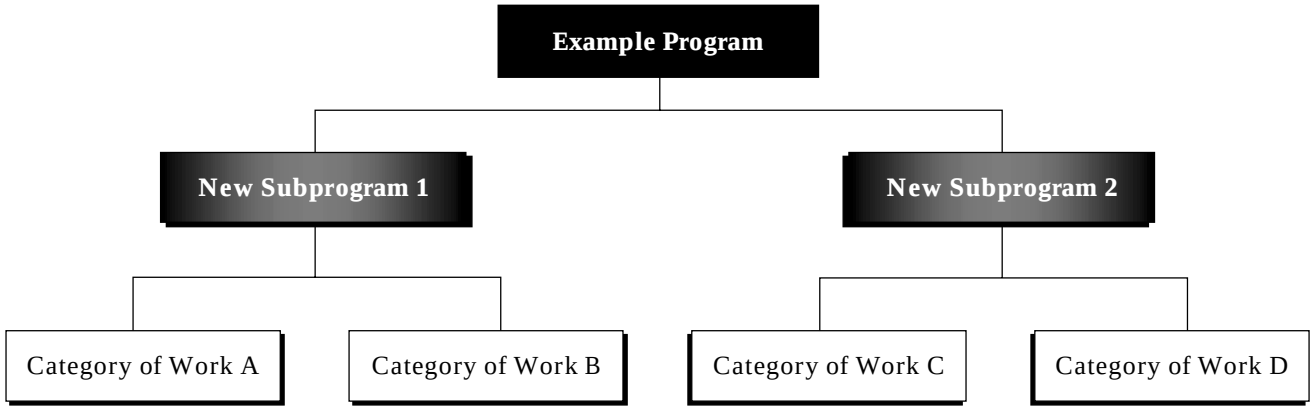


Figure 6.4 New, More Streamlined Program Structure



An improvement program could include individual subprograms for mobility and safety, and even a broad breakdown of mobility-related work at this level. However, treating distinctions among various types of capacity and operations improvements (e.g., turning lanes, climbing lanes, signalization improvements, variable message signs, etc.) at too high a level in the program structure has the same shortcoming as discussed above for preservation.

Figures 6.3 and 6.4 are schematic – they should be interpreted in terms of the different structures they represent, not in the literal number of programs, subprograms, and categories of work shown. Also, they need to be understood in context. If your DOT refers to what are called "programs" in these figures as, say, "capital program categories," and your "programs" correspond to what are labeled "subprograms" in these figures, then the nomenclature in this discussion must be adjusted and interpreted accordingly. While this example is schematic, it nonetheless illustrates the advantages of a streamlined program structure:

- Managers can be more flexible in crafting alternative approaches for solving problems within a broad arena, rather than being unduly constrained by a large number of narrow, predefined subprograms.
- There is less tendency with a streamlined structure to dilute available funding across a large number of subprograms, and there is less risk that these many subprograms will result in non-optimal uses of scarce funds.
- A streamlined program structure facilitates comparison and evaluation of competing solutions, program tradeoffs, and reporting of performance results, but can still accommodate a variety of types of projects.
- A streamlined program structure helps to visualize and communicate the composition and

rationale of the transportation program. Properly structured, it also helps to identify how the transportation program is meeting stated policy objectives by focusing on the outcomes of broad program categories, rather than narrowly defined differences among types of projects.

- Other considerations can be "overlaid" on the program structure used for resource allocation if more detail is needed for other reasons such as the following:
  - Financial management of different "pots" or "colors" of money and related project eligibility requirements;
  - Need for geographic or equity-based distributions; and
  - Statutory or management reports that require a different reporting structure.

6.4.2 CONSISTENCY IN PROGRAM DEFINITION

Program structure can be organized in different ways to provide these advantages, so long as the definition is consistent throughout. Some ways in which a program can be defined include the following:

- By type of asset: e.g., highway, rail, aviation; or roadway, railway, runway, structures, etc.
- By transportation policy or system objectives: e.g., mobility, preservation, safety, etc.
- By type of improvement or solution: e.g., major capacity improvement, minor capacity/system improvement, pavement preservation, safety, operations, etc.

Difficulties can arise in a performance-based approach if the definition of the program structure is not consistent. Consider a program, for example, that is defined in several ways: by policy objective (e.g., roadway preservation, safety), by type of work (e.g., capacity improvement and operations improvement), by asset class (e.g., bridge program), and funding source (e.g., federal congestion mitigation). While it may be possible to manage a capital program that is defined in this way, consider the difficulties of answering basic questions as to what is being accomplished with program investments:

- How much is being devoted to preservation? to mobility? to safety?
- What will it take to improve preservation (or mobility or safety) performance by 10 percent?
- What are the key tradeoffs that need to be investigated?
- Are policy objectives in preservation, mobility, and safety being met? If not, where are increases needed, and by how much?

Each of these questions entails looking not only at multiple components of the program described above, but in some cases portions of programs (e.g., the bridge program includes new construction as well as preservation). A consistent method of defining a program structure will not eliminate all the calculations that are needed to answer the questions above, but it will put these calculations on a uniform basis and reduce the possibility of double-counting or inadvertently omitting a key contribution.

While effective definition clarifies the program structure, to work the definitions must be enforced. If your agency has both a preservation program and a safety program, then projects that have both kinds of work should be reflected in both programs.[6]

6.4.3 HOW MAY THESE STEPS HELP?

Taken together, a streamlined program structure and consistent definition of that structure will yield a program that:

- Allows greater latitude in identifying options to address problems;
- Is consistent with prioritization procedures that allow candidate projects to compete with their peers;
- Provides flexibility in facilitating tradeoffs among program categories;

[6] It is possible to identify incidental or minor spot safety work that would normally be associated with pavement preservaton projects and to place a limit on the amount of this work that can be funded through preservation. This will avoid unnecessary administrative burdens while maintaining the essential ingredients of a performance-based approach.

- Is clear and enforceable as to the types of projects in each program and subprogram; and
- Is meaningful and easily communicated.

6.5 MAINTENANCE AND OPERATIONS PROGRAMMING

The state-of-the-art in program development for maintenance and operations today is an approach referred to as "maintenance quality assurance," or MQA or simply QA. This approach is likewise performance-based, and is consistent with asset management concepts and principles.

6.5.1 WHAT IS MAINTENANCE QUALITY ASSURANCE?

NCHRP Project 14-12 has described a Maintenance Quality Assurance program as "planned and systematic actions needed to provide adequate confidence that highway facilities meet specified requirements. Such requirements are usually defined by the highway agency but are intended to reflect the needs and expectations of the user."[7] While the NCHRP project report reviews a number of management practices that support this objective, the QA approach that it has developed is fundamentally performance-based and centers on the concept of maintenance "level of service," or LOS. An MQA approach based on levels of service can accomplish a number of purposes:

- To determine the LOS expectations the traveling public supports and is willing to pay for;
- To communicate to the public how the agency is meeting these expectations;
- To seek levels of funding needed to achieve the desired LOS;
- To develop a "priority strategy" to focus on key maintenance activities when funding is less than requested;
- To achieve a more consistent application of LOS throughout the agency (e.g., for highways of a particular class and traffic usage) by identifying locations of excessively high or low maintenance; and
- To identify areas requiring additional employee skills or equipment to accomplish assigned tasks.

6.5.2 MQA FRAMEWORK FOR MAINTENANCE AND OPERATIONS MANAGEMENT

Maintenance QA introduces a performance-based framework for maintenance and operations management as illustrated in Figure 6.5. Several elements of this framework are drawn from traditional approaches to highway maintenance management: e.g., activity performance standards and cost models. The new elements that are added by a QA approach are those related to performance-based management:

- The explicit determination of condition of maintained highway features;
- Levels of maintenance service that are related to highway condition or to the quality of services provided; and
- Impacts of level of service (and associated highway condition) to customers.

Following is a brief discussion of each of the elements of this framework, which will assist in interpreting the different ways in which several states have implemented a QA program for maintenance and operations.

CURRENT CONDITION OF HIGHWAY FEATURES

The current condition of maintained items in the highway system is tracked through periodic inspection surveys. Since complete surveys encompassing all highway features would be difficult and expensive to conduct, DOTs often employ statistical sampling. While legacy maintenance management systems typically have an inventory of maintained highway features, they often have no provision to record feature condition over time. The addition of data on facility condition is one key element of a QA approach, and it is used to establish the current LOS value in each maintenance activity group and district.

[7] M.L. Stivers, K.L. Smith, T.E. Hoerner, and A.R. Romine, **Maintenance QA Program Implementation Manual**, NCHRP Report 422, National Academy Press, Washington, D.C., 1999, p. 9.

TRAFFIC AND ENVIRONMENTAL CONDITIONS

Traffic and environmental classifications can be recorded for each highway segment to help group it for purposes of maintenance management reporting. For example, urban highways may exhibit different demands for maintenance and different unit costs from those on rural highways. Similar distinctions can be made for environmental or geographical zones to reflect the influence of terrain, altitude, local weather conditions, and other factors on maintenance demand, performance, and cost. The classification of each highway segment can be accomplished during initial development of the QA approach and recorded in an inventory file.

APPLICABLE MAINTENANCE LEVEL OF SERVICE

The applicable maintenance LOS is specified by managers as the desired level to which each highway feature should be maintained. It is referred to as the *target LOS* to distinguish it from the *current LOS* that reflects the existing condition observed in the inspection survey. Target LOS values are expressions of maintenance management policy and priority, and play an important role in determining a performance-based budget estimate for the maintenance program, and in influencing the level of maintenance that is perceived by the public. It is for these reasons that LOS values are key ingredients of a maintenance QA program. Individual target LOS values are specified for each maintenance activity (or group of activities) in each district. In setting target LOS values, managers can account for needed adjustments in program priorities, and should reflect a realistic anticipation of maintenance funding. It is important to note, however, that level of service also can be used as an important argument for increases in maintenance funding when the projected benefit is compelling.

DEMAND FOR MAINTENANCE WORK

The combination of items above – the current condition (and LOS) of highway features, their characteristics and location (in terms of traffic and environment), and the target LOS value to which they will be maintained – determine the demand for maintenance work to be provided. In maintenance QA programs, this demand is estimated as a function of LOS.

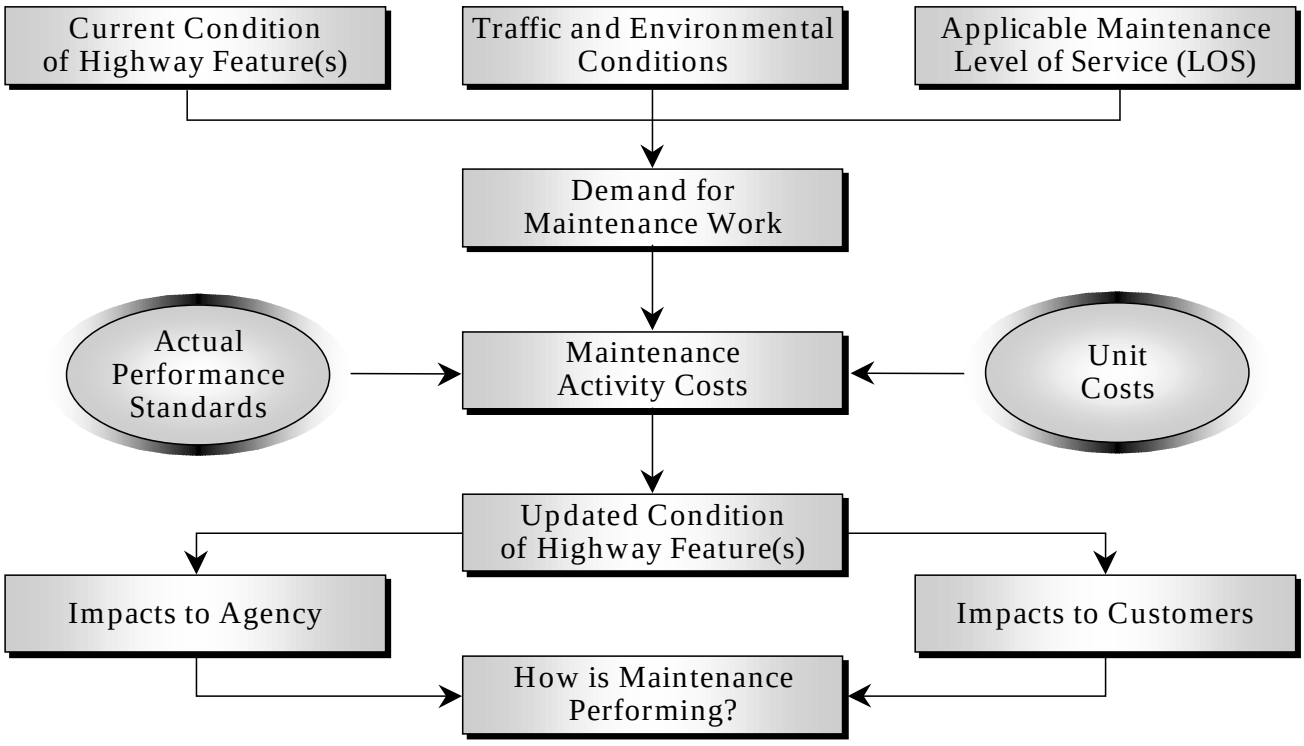
This "demand" for maintenance translates into the estimated work to be performed. It is computed for each activity in each district. The total demand or level of maintenance is recorded in units of work accomplishment, typically the same measures as those used in an existing maintenance management system. Note that this estimated level of maintenance is directly a function of the target LOS specified by managers. If the target LOS is revised, in general the demand for maintenance will likewise adjust.

MAINTENANCE ACTIVITY COSTS

Costs can be estimated for the levels of work computed above, using procedures similar to those employed in existing maintenance management systems. Separate calculations of labor, equipment, and materials can be made, using performance standards and respective unit costs as shown in Figure 6.5. Alternately, an overall activity cost can be computed from the total unit cost per accomplishment unit for labor, equipment, and material combined. The performance standards are referred to as "actual" in Figure 6.5 to denote that it is the actual resource usage rates and crew productivity that should be used in these calculations, not necessarily the "book values" that are listed in the highway maintenance manual.[8] Performance standards (and unit costs) for each activity will in general vary by district, and possibly by the traffic and environmental classifications discussed above. Existing maintenance management systems may not estimate costs to a level of detail sufficient to account for these variations; the QA approach affords an opportunity to do so if warranted. Costs as a function of LOS are computed by the QA analytic procedure.

[8] "Book" values may be used if they reflect up-to-date information for the district, region, or area of interest. Statewide average values that have not been updated recently tend not to be realistic, and more specific, current information should be sought.

Figure 6.5 Maintenance Quality Assurance Framework



UPDATED HIGHWAY CONDITIONS AND IMPACTS

The QA approach considers the benefits or consequences of maintenance as well as its costs. Benefits are reflected by the predicted change in highway conditions that will result from performing maintenance activities to the specified levels of service. These updated conditions have implications for both the highway agency and its customers:

- The agency impacts are in terms of the effect of maintenance on the long-term trend in highway infrastructure condition. By sustaining LOS values at a high level, an agency can avoid building up a "backlog" of maintenance work, and keep maintenance costs at an efficient level over the long term.
- The customer impacts are in terms of highway rideability, safety, comfort, and travel time that are associated with the LOS provided. By sustaining LOS values at a high level, an agency can provide road users with high-quality transportation facilities and services over the long term, cost-effectively.

The current state-of-practice in maintenance QA programs is to use the target LOS value as a surrogate, or proxy, for these specific agency and customer impacts. The data needed for more explicit predictions of the impacts of different maintenance LOS values may become available in the future with additional research.

HOW IS MAINTENANCE PERFORMING?

The QA approach provides a feedback loop by which managers can assess how the maintenance program has performed and adjust the program accordingly. Measures of current performance are the current LOS values; adjustments can then be made through the target LOS values in the next program budget cycle. Level of service thus provides a measure of management accountability, and a means of communicating program accomplishments and customer value provided for dollar spent.

6.5.3 IMPLICATIONS OF AN MQA APPROACH

An MQA approach has several implications for maintenance management:

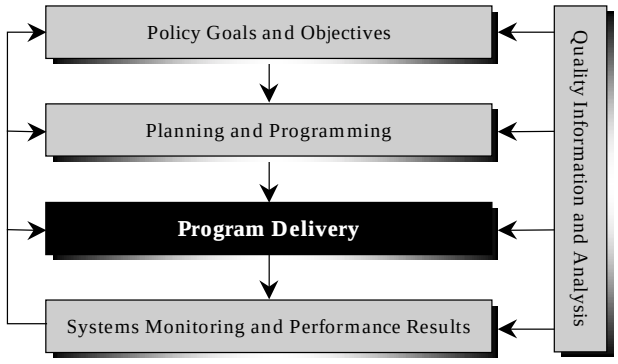
- It is a performance-based approach, in that maintenance levels of effort and cost are based upon current highway condition and proposed LOS targets, and these calculations are implemented within a performance budgeting procedure. Moreover, the target LOS values provide a basis for management accountability for maintenance performance, and the periodic surveys of highway condition establish a quantitative basis for this accountability.
- MQA also is a policy-driven process, as reflected in the setting of target LOS values. To be successful, this process must involve appropriate political decision-makers (e.g., governor's office, legislative committees, the transportation commission or board) as well as DOT executives.
- As a policy-driven, performance-based approach to management, MQA is entirely consistent with a broader set of principles of good practice in transportation asset management.

7. PROGRAM DELIVERY

7.1 OVERVIEW

Resource allocation decisions result in a recommended transportation investment program. Program delivery puts this program "on the ground" through decisions in resource utilization to determine how program work will be accomplished. Its sequence in the asset management framework is shown in Figure 7.1. Key challenges for program delivery include maximizing efficiency and effectiveness of agency resources, meeting customer expectations, minimizing adverse customer impacts, adhering to project scope, schedule and budget, and managing needed changes in projects and programs.

Figure 7.1 Program Delivery within Resource Allocation and Utilization



This chapter illustrates the application of asset management principles to program delivery. It highlights opportunities to optimize the implementation of capital programs, maintenance activities, and operations plans through strategies such as the following:

- **Investigating a range of delivery options**. Assessment of options with consideration of relative costs, benefits and risks, both immediate and long term.
- **Program management**. Close monitoring and management of project and budget status to ensure that desired results are achieved.
- **Cost tracking**. Tracking of actual delivery costs to improve understanding of the true costs of different activities so that this information can be used to enhance future resource allocation decisions.

7.2 ALTERNATIVE DELIVERY METHODS

7.2.1 RANGE OF OPTIONS

Transportation agencies have a range of delivery alternatives available to them. Several non-traditional delivery techniques have been developed and applied by U.S. transportation agencies to reduce time to completion, improve cost-effectiveness, address project complexity, supplement staff skills with specialized expertise, and use in-house resources more effectively. Examples of these techniques include the following:

- Innovative contracting approaches;
- Performance-based bidding;
- Intergovernmental agreements; and
- Outsourcing and managed competition.

When analyzing these and other delivery options, the following issues should be kept in mind:

- Delivery methods should be evaluated on a case-by-case basis. A thorough analysis of project, owner, and market characteristics will help identify legitimate delivery options.[1]
- Although external issues may constrain delivery alternatives (e.g., state or federal procurement laws may prohibit certain procurement approaches), motivated agencies can often customize procurement strategies to meet their specific needs and constraints.
- The methods presented in this chapter may require construction documents, proposal evaluation guidelines, and oversight techniques different from those used in traditional procurement strategies. Care should be taken to structure the procurement to maximize benefits and mitigate potential risks.
- Since alternative delivery strategies give agencies flexibility in terms of project cost, schedule, and the use of in-house resources, these options

[1] Christopher Gordon, "Choosing Appropriate Construction Contracting Method," **ASCE Journal of Construction Engineering and Management**, Vol. 120 No. 1, (Mar 1994).

should be considered early on in the planning and programming processes.[2]

7.2.2 CONTRACTING APPROACHES

State DOTs have developed and implemented innovative contracting approaches in an attempt to improve the cost and time of program delivery or provide needed expertise more efficiently. These mechanisms include assigning responsibility for both design and construction to a single entity, corridor approaches to asset management, and internal adjustments in an agency's pre-construction activities. While such contracting approaches present advantages in certain situations, conventional methods of delivery (i.e., design-bid-build in construction, and performance of maintenance by agency employees) will continue to be used for many projects and activities. Selection of the appropriate delivery method is an example of decisions in "resource utilization" in an asset management context.

Federal Funding for DB Projects

The Transportation Equity Act of the 21st Century (TEA-21) established federal funding eligibility rules for DB projects: ITS projects over $5 million and other projects over $50 million qualify for TEA-21 funds. However, in its proposed guidelines for DB contracting, the FHWA acknowledges the potential benefits of DB contracting for projects of all sizes.[3] The FHWA recommends that agencies opting for DB contracts for projects under the TEA-21 thresholds pursue federal funding through FHWA Special Project No. 14 (SEP-14), Innovative Contracting.

DESIGN-BUILD

Design-build (DB) contracts are one approach to combining design services and construction work into a single contract. Time savings are possible under this arrangement because construction can begin before design is complete. Between 1991 and 2001, 24 DOT's and several local agencies used DB contracts for transportation projects as an alternative to the traditional design-bid-build (DBB) process for 140 projects ranging in size from pavement overlays to freeway construction and reconstruction.[4]

A 1992 study[5] documented the following impacts of DB contracts on project schedule and budget:

- DB projects are completed 21 percent faster than traditional design-bid-build (DBB) projects.
- Initial costs of DB projects are 4.6 percent higher than DBB costs.
- Cost growth due to claims and change orders for DB projects is 4.7 percent less than for DBB projects.

Design Build Example

Utah DOT employed DB on its $1.59 billion reconstruction of a 16-mile length of Interstate 15 in Salt Lake City. This project involved roadway widening from six to 12 lanes, and reconstruction of 142 bridges and other structures, and 12 interchanges. It was estimated that the project would have required eight to ten years to complete utilizing a traditional DBB procurement process. However, in January 1996 the Governor directed the Utah DOT to complete the project in five and one-half years – in time for the 2002 Winter Olympics. The DOT quickly determined that this acceleration would be possible only with a DB contract, which required authorizing state legislation. The DOT selected a program management firm to assist in guidance of the project along with the Department. This firm helped manage the evaluation, selection and award process, leading to a notice to proceed to the selected DB consortium in April 1997.

Early construction starts were accomplished with no design submittals to the Utah DOT, which had oversight/ over-the-shoulder review responsibilities only. ISO 9001 registration required the design-build consortium to establish procedures and standards for quality. Ribbon cutting for the $1.59 billion project occurred on May 14, 2001, five months ahead of the contract completion date, and four to six years ahead of the original procurement estimates.[6]

[2] John B. Miller, **Principles of Public and Private Infrastructure Delivery,** Kluwer Academic Publishers, 2000.

[3] Federal Highway Administration, *Design-Build Contracting; Proposed Rule* (2001). www.transportation.org/committee/design/doc/Federal_Register_NPRM_Design-Build.pdf

[4] Ibid.

[5] Ibid.

[6] Thomas R. Warne and David G. Downs, "All Eyes on I-15", *ASCE Civil Engineering Magazine* (Oct 1999).

CORRIDOR APPROACH

A corridor approach to asset management is another fast-tracking alternative. In this approach, agencies combine several capital projects or maintenance activities along a section of highway into a single project. This approach, which is used to minimize the inconvenience of the traveling public, follows an increasingly popular philosophy to "get in, get out, and stay out."

"Get In, Get Out, and Stay Out"

One "get in, get out, and stay out" approach is to close a length of highway completely so that maintenance or construction crews and utility companies can perform all necessary work simultaneously. Current practices range from closing a highway section overnight or a weekend to more extensive closures of several months for reconstruction. For example, the California and Michigan DOTs have applied a corridor approach to delivering capital projects.[7]

CUSTOMIZED APPROACHES

Transportation agencies also have developed customized contracting and procurement approaches that fit into their specific funding, institutional, and legislative environment, and have adjusted those internal activities that tend to prolong the delivery process.

While revised contracting approaches and internal process adjustments offer significant opportunities to decrease delivery time, they are not always appropriate for every project. For example, state legislation may constrain procurement options and approval processes, or an agency may want design of a project to be 100 percent complete before contractors bid on it. In addition, a faster delivery time for a project increases the share of funding that must be allocated to the project (e.g., completing a mega project in three years instead of five years may require that other projects be scaled back or delayed until year four). Understanding the full costs and benefits of innovative delivery approaches is essential to a meaningful evaluation of this alternative.

7.2.3 PERFORMANCE-BASED BIDDING

Asset management calls for system performance to drive decisions throughout the project life cycle. State DOTs have developed several options for incorporating performance-based concepts into program delivery. Following is a brief description of a few of these techniques.[8]

[7] Federal Highway Administration, *Work Zone Safety Best Practices Guide* (2000). <www.ops.fhwa.dot.gov/wz/wzguidbk/>

[8] Federal Highway Administration, **Initiatives to Encourage Quality through Innovative Contracting Practice -- Special Experimental Project No. 14 – (SEP 14).** <www.fhwa.dot.gov/programadmin/contracts/sep_a.htm>

Customized Approaches to Reducing Delivery Time

Constrained by state legislation that restricted DB contracts, the New Mexico DOT developed a unique delivery approach (design, construction manage, warrant) to reconstruct 120 miles of State Route 44 in three years. Under this approach, a project developer was responsible for overall project management, quality control, bid package preparation, and maintenance during an extended warranty period. The DOT estimated that the project would have taken 27 years with its traditional procurement process.[9]

In another example, the Washington State DOT cut the delivery time for the South Dupont Interchange on Interstate 5 from four to eight months to 26 through a series of internal process improvements:[10]

1. Commencement of the environmental review process earlier in the project, and incorporation of environmental considerations into the design process.

2. Design process enhancements: selection of a "Top Gun" design team, a streamlined design review process, stage submittals in which work proceeded based on engineering estimates rather than waiting for final information, and commencement of bridge design before the interchange plan was approved.

3. Reduction of common third-party delays by including utility work in the construction contract.

4. Inclusion of design alternatives in the contract documents rather than requiring contractors to submit shop drawings for approval.

- **Performance specifications** are an alternative to traditional prescriptive specifications that enable bidders the flexibility to propose innovative solutions. Performance specifications require bidders to meet a defined level of service or quality without stating how to meet these criteria.
- **Cost plus time bidding** (also referred to as A+B bidding) requires bidders to submit a time bid (e.g., number of calendar days until completion) in addition to a traditional cost bid. When evaluating the total cost of the proposals, the owner uses the time bids to estimate the user costs associated with each proposal. This arrangement encourages bidders to minimize time to completion.
- **Best-value bidding** is used to select contractors based on a combination of lowest cost and bidder qualifications or technical merit of a proposal.
- **Lane rental**, like cost plus time bidding, encourages contractors to minimize construction impacts on road users. Contractors are charged a "rental fee per-lane per time" to occupy the roadway throughout the project.
- **Life-cycle cost bidding** is an alternative to traditional lowest cost bidding. In this approach, the owner evaluates bids based on the projected costs over the entire life of a project.
- **Incentive contract clauses** provide contractors with monetary awards for achieving defined performance and schedule benchmarks throughout the course of a project.
- **Warranty periods** enable an owner to guarantee the performance of a new facility for a given time. Warranty provisions on National Highway System projects are limited to specific features (e.g., pavement, structures, etc.) and may not include routine maintenance.

7.2.4 INTERGOVERNMENTAL AGREEMENTS

Intergovernmental agreements can create opportunities to improve the efficiency and cost effectiveness of delivering projects and services. For instance, a state DOT may purchase or exchange maintenance services with a municipality, or expand the capabilities of a county agency through training in exchange for work performed by the county for the DOT.

Intergovernmental agreements have several advantages:[11]

- Cost savings through the sharing of expensive equipment and employee expertise between agencies.

[9] Mesa, PDC, LLC, *A Summary of the New Mexico State Route 44 Project* (2000). <www.nm44.com/pdf/NM%2044%20Project%20Summary.pdf>

[10] Cambridge Systematics, Inc., *Department of Transportation Highways and Rail Program Performance Audit*, prepared for the State of Washington Joint Legislative Audit and Review Committee (1998).

[11] Municipal Research and Services Center of Washington Report No. 27, **Municipal Cooperation Guide** (1993). <www.mrsc.org/pubs/municoop.pdf>

Utah DOT's Performance-Based Procurement

Forced with a very tight schedule for the reconstruction of Interstate 15, the Utah DOT used a variety of performance-oriented requirements. The request for proposal (RFP) included a mixture of performance and traditional prescriptive specifications, best value selection, and stipends (a first for a publicly funded major interstate highway project). Structures, pavements, lighting and several other design elements were governed by performance specifications. For example, the specifications for pavement markings consisted only of a color and retro-reflectivity requirements. Examples of innovations fostered by the performance specifications include the use of polystyrene instead of traditional borrow material to minimize soil settlements and an innovative traffic maintenance strategy that exceeded the Utah DOT's expectations.

Long-term warranty requirements in areas of critical quality (structures, pavements, embankments, drainage) forced life-cycle cost analysis by the DB consortium and up-front quality in design and construction. To give the warranty added force, the contract included an operations and maintenance option under which the consortium would be responsible for these activities for up to 10 years at a fixed price. Although the Utah DOT ultimately did not exercise this option, the consortium's design and construction decisions were always influenced by the knowledge that they might have the maintenance responsibility to correct any long-term problems.

An incentive fee in the maximum amount of $50 million was available to the DB consortium for optimum performance in the areas of schedule, quality, management, and community relations/maintenance of traffic. The Utah DOT evaluated the consortium's performance in these areas in six-month intervals throughout the project, and distributed the award money accordingly.[12]

- Increased efficiency through the elimination of duplicate efforts and economies of scale.
- Access by local agencies to services that they would otherwise be unable to provide.
- Opportunities for state agencies to redirect local resources toward mutually beneficial projects.

[12] Thomas R. Warne and David G. Downs, "All Eyes on I-15," **Civil Engineering** (Oct 1999).

Michigan DOT's Alternate Bidding

In cooperation with representatives of the concrete and asphalt paving industries, the Michigan DOT developed an RFP that enabled bidders to submit bids for one of two "equivalent" pavement designs. The RFP included specifications for both an asphalt and a concrete pavement design. The bids were evaluated based on the lowest life-cycle-cost of the proposed pavement design rather than the traditional lowest initial construction cost. In addition, the RFP included a short-term warranty to cover materials and workmanship, and incentives for extraordinary pavement performance.[13]

Pennsylvania DOT's Win-Win Agreements

Through its Agility Program, the Pennsylvania DOT has developed working relationships with more than 1,500 of its local partners. The program encourages the DOT and local participants to identify win-win opportunities for sharing resources across jurisdictional boundaries. For example, in one agreement, the Pennsylvania DOT widened a township road. In exchange, the local partner agreed to sweep various state roads within the township. In the first four years of the program, the DOT has estimated a total savings for all participants of over $7.7 million.[14]

7.2.5 Outsourcing and Managed Competition

Further opportunities for delivery optimization exist though contracting with the private sector to perform maintenance and operation activities. The potential benefits of outsourcing include lower overall costs, improved service, and opportunities to leverage the expertise of private companies and overcoming in-house staffing constraints. Factors to consider when analyzing the tradeoffs between in-house and outsourced work include:

[13] Michigan DOT, **Alternate Bid Study M-6 South Beltline** (2000). <www.mdot.state.mi.us/projects/retired/m-6/altbids.pdf>

[14] Pennsylvania DOT, **Status of the Agility Program** (2001). <www.dot.state.pa.us/Internet/Agility.nsf>

- Capability of in-house staff capable to improve the quality or cost-effectiveness of services.
- Methods by which to monitor work activities and ensure quality and performance.
- Availability of accurate cost data for comparing in-house versus outsourcing costs (activity-based costs are discussed in later sections).
- Internal costs and experience requited to administer outsourcing contracts (e.g., developing RFP and selection process, cost of transition period, etc.).
- Distribution of project risks between owner and contractor and the impact on costs (e.g., although the private sector may charge a premium to assume all risks during a five-year fixed fee contract, the public agency will know the exact cost of a set of activities over the life of the project).
- Need for a "safety net" if public employees are displaced by a private-sector work force.

In addition to contracting maintenance and operations to the public sector after a facility has been built, outsourcing is possible through the combination of these activities with design and/or construction during the original procurement process. Options for approach include design-build-operate (DBO), design-build-operate-maintain (DBOM), build-operate-transfer (BOT), and design-build-operate-transfer (DBOT) procurement strategies.

An alternative to direct outsourcing is managed competition. This practice has all of the potential advantages of direct outsourcing contracts but also gives the current in-house staff the opportunity and the means to compete against their private sector counterparts in terms of quality and price.

Outsourcing Florida DOT's Program Management

Florida's Turnpike District is one of the Florida DOT's eight districts. It consists of 440 centerline miles of toll roads, approximately 653 bridges, 215 buildings, numerous toll plazas, and communications facilities, spread out over South and Central Florida. For over 10 years, the Florida DOT has managed its Turnpike facilities with consulting contracts for design, construction and maintenance management services.

Nearly 100 percent of the Turnpike's maintenance services are contracted for by the Florida DOT. Overall maintenance program management is provided by a joint DOT/contractor team. Contractor services include annual program and budget planning, road and facilities inspections and needs assessments, emergency operations planning, environmental services, oversize-overweight and access permit management, and procurement and supervision of all routine and specialized maintenance services. At any given time, there are over 100 maintenance and service contracts in effect. The contract involves a staff of approximately 75 people and fees of approximately $5 million per year and is renewed at five-year intervals. The contractor team is composed of highway, bridge and traffic engineers, environmental scientists, contract administrators, and a variety of skilled maintenance technicians and administrative staff members.

The focus of the contract is patron service and safety and protection of bondholder interests. The project is subject to annual quality assurance reviews by the State Maintenance Office.[15]

[15] Wendell C. Lawther, **Privatizing Toll Roads - A Public-Private Partnership**, Praeger Publishers (2000).

Outsourcing Maintenance at the Virginia DOT

In 1995, the Virginia General Assembly enacted the Public-Private Transportation Act (PPTA). This legislation permitted private companies to submit both solicited and unsolicited proposals for constructing, maintaining or operating various facets of Virginia's transportation system. The underlying rationale for the Act was to afford greater opportunity to the private sector to develop innovative and cost-effective solutions to the many transportation issues confronting the Commonwealth.

In 1996, the Virginia DOT received an unsolicited proposal pursuant to the PPTA. This proposal resulted in a negotiated agreement for the private contractor to perform maintenance services for 25 percent of the Commonwealth's interstate highway system. The private contractor was to provide outcome-based routine maintenance services and required restorative work, such as roadway resurfacing and bridge deck replacement, on 1,250 lane miles of roadway on segments of I-95, I-81, I-77 and I-381. The sections of the Virginia interstate system that were covered in this agreement are highlighted in Figure 7.2 (following page).

The agreement addressed the full range of maintenance services, including snow removal and emergency response, required to meet the performance standards established by the Virginia DOT. In December 1996, the Virginia DOT and the private contractor entered into a five and one-half year, $131 million fixed price contract. The DOT preliminarily estimated that the contract represented a savings of $22 million to the Commonwealth.

VDOT Outsourcing

Recognizing that this was an unproven approach, the Virginia DOT designated the maintenance contract as a pilot project intended to address two key questions:

1. Whether privately contracted asset management can provide equivalent or better levels of service in interstate maintenance; and

2. Whether privately contracted asset management can provide such services at lower costs.

Over the course of the contract, the Virginia DOT has worked to develop and modify its evaluation structure to present a fair representation of the contractor's performance. Based upon an evaluation in FY 2000, it appears that the contractor had met or exceeded the DOT's performance targets for 90 percent of the items evaluated on I-95, 89 percent on I-77, 86 percent on I-81 and 86 percent on I-381. The Virginia DOT's evaluations currently are conducted on an annual basis. A legislative commission has suggested that quarterly evaluations would identify problem areas sooner and would be a more effective approach.

Regarding cost, the Virginia DOT contracted with the Virginia Polytechnic Institute and State University (Virginia Tech) to provide an objective assessment of this controversial aspect of the outsourcing contract. The Virginia Tech study utilized a bid item and unit rate comparison of the cost of work performed by the private contractor in calendar year 1999 and corresponding published Virginia DOT bid tabulations. The study concluded that:

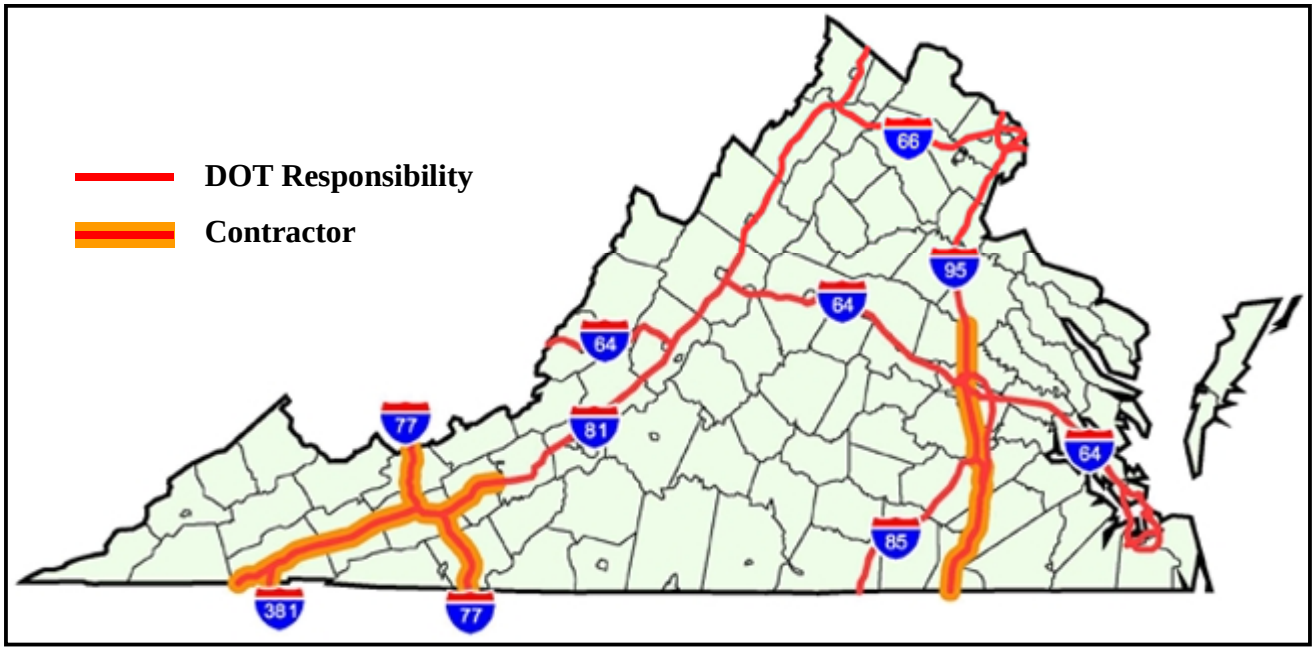
1. Work subcontracted by the contractor was four percent more competitively priced than similar work would have been if it had been let by the DOT.

2. Work self-performed by the contractor was likely to be 6.1 percent cheaper than comparable work if contracted for or self-performed by the DOT.

3. The estimate of total project savings once price escalation was accounted for was likely to be $18.7 million.[16]

[16] Joint Legislative Audit and ReviewCommission of the Virginia General Assembly, **Review of VDOT'S Administration of theInterstate Management Contract**, 2001.

Figure 7.2 Virginia DOT Maintenance Outsourcing Map



Massachusetts Highway Department's Phased Approach to Maintenance Outsourcing

The Massachusetts Highway Department (MHD) began its outsourcing effort by contracting out all routine maintenance in a single county. It has been estimated that after one year, the program saved the MHD between $1.7 million and $2.1 million. Based on this estimate, the MHD expanded the program to two districts and let the state work crews to bid on the projects. (See the discussion on managed competition below.) Further success in this second phase (estimated first year savings of $7.5 million and $10 million in additional maintenance services) gave the MHD confidence to institute the program statewide. In the final phase of the program, MHD employees and private firms each won seven of 14 maintenance contracts. After the initial contracts had expired, the rebidding process received little attention from the media – maintenance outsourcing had become an accepted practice in Massachusetts. In the first eight years of this program, the MHD cut its $40 million annual highway maintenance budget by an ***estimated $15 million,*** *while significantly increasing the amount of work performed.*[17]

A key issue with managed competition is to develop a procurement process in which in-house and public bids compete fairly. Without such a "level playing field," private firms will be unwilling to develop quality bids, and the benefits of bringing the public sector into the process will be greatly diminished. Challenges that must be overcome when developing a level playing field for a managed competition include:[18]

- Separation of government as bidder from government as owner.
- Ability of in-house staff to compute the actual cost of an activity (including overhead, administration, depreciations, and legal costs). Cost tracking techniques are explored further in the last section of this chapter.

[17] Adrian Moore, "Road Work Ahead: Outsourcing Highway Maintenance", **Intellectual Ammunition** (Nov/Dec 2000).<www.heartland.org/ia/novdec00/privatization.htm>

[18] Reason Public Policy Institute (RPPI) Privatization Center, **Avoiding Managed Competition Pitfalls**. <www.privitization.org/collection/PracticesAndStrategies/Avaoiding_Managed_Competition_Pitfalls.htm>

Outsourcing Operations at the OOCEA

The Orlando Orange County Expressway Authority (OOCEA) is the owner of the toll road system in Orange County, Florida. The system consists of 90 miles of toll roads and 11 plazas. In 1994, the OOCEA awarded a five-year contract to a private operator for toll operations services on this system. Previously, the agency had contracted with the Florida DOT to provide these services. Most of the private operator's toll collection staff transferred from the DOT, but new management oriented toward private sector business principles was installed. In 1999, the OOCEA extended the private operator's contract for an additional five years.

The objectives of this outsourcing effort were to reduce operations costs, increase managerial flexibility, and improve service quality and responsiveness. In 2000, an independent study found that the agency was largely successful in achieving these objectives.[19] Increased efficiencies were estimated to produce savings of over $1 million annually, a one-sixth reduction. Improved managerial flexibility was demonstrated by the ease with which the operator was able to quickly adjust the mix of full-time and part-time toll collectors in response to changing conditions – adjustments that would have been difficult for the state DOT to accomplish. The study cautioned that it was not always possible to distinguish between improvements caused by privatization and improvements due to other factors.

- Costs by private bidders to meet bonding and insurance requirements.
- Special privileges and tax exemptions for public agencies (sales tax, corporate income tax, property tax, etc.).
- Private sector costs of developing proposals.
- Difficulty in subjecting in-house staff to performance or cost guarantees.

7.2.6 SUMMARY

- A summary of delivery mechanisms discussed above is given in Table 7.1.

[19] Wendell C. Lawther, **Privatizing Toll Roads – A Public Private Partnership**, Praeger, 2000.

Iowa DOT's Managed Competition

In 1996, the Iowa DOT implemented a pilot managed competition program for two of its activities: paint striping ($2 million annual budget) and sign shop ($1 million annual budget). Program guidelines included the following:

1. Private sector bids competed against activity-based cost (ABC) proposals developed by existing state work crews.

2. Outside consultants were hired to reengineer DOT operations, develop ABCs, and prepare proposals.

3. In-house bids included all direct and indirect costs.

4. A five percent preference was given to the in-house bid.

5. A safety net was developed for displaced state workers.

Iowa DOT employees were the low bidders for paint striping and sign manufacturing, and a private firm was the lowest bidder for graphic display sign work. It is estimated that internal improvements in paint striping operations in response to this program saved the DOT more than $300,000 annually, and the DOT demonstrated that existing sign shop operations were competitive with private sector alternatives.[20]

7.3 PROGRAM MANAGEMENT

Program management is necessary for an agency to implement a capital or maintenance program effectively. By applying asset management principles to its program management approach, and agency can:

- Insure that the approved program is implemented;
- Match available funds and workforce resources to delivery needs;
- Identify opportunities for improvement in its planning and programming processes; and
- Keep all stakeholders up to date on the status of program implementation.

[20] Jim Chrisinger, **Managed Competition Pilot Projects: Iowa Department of Transportation**, a National Academy of Public Administration report (1996). <www.alliance.napawash.org/ALLIANCE/Picases.nsf/e24ffc586e80044a852564ed006eb5be/0091ca9c8412ad788525656a00752035? OpenDocument>

Table 7.1 Delivery Method Summary

Delivery Method	Advantages	Challenges	Implementation Examples
Fast Tracking			
Design-build, DBO, DBOM, BOT, DBOT, and other non-traditional procurement strategies	Shorter delivery period, single point of responsibility for owner to oversee, decrease in cost growth due to change orders	TEA-21 thresholds, state statutes, lack of experience managing DB contracts	Utah I-15 DB, New Mexico SR 44 design-construction manage-warranty, Massachusetts Route 3, DBOM examples from 24 state DOTs
Corridor approach	Shorter delivery time, minimal inconvenience to traveling public	Contractor bonding limits, limitations in the size of the local work force	Michigan DOT corridor planning and weekend closures, Caltrans nighttime closures
Performance-Based Bidding			
Performance specifications	Flexibility for contractor to propose innovative solutions	All of the performance-based bidding techniques require construction documents, proposal evaluation guidelines, and construction oversight techniques that vary significantly from those of a traditional procurement process	Utah I-15 design-build, Florida I-75 asset management,
Cost plus time bidding	Shorter construction times encouraged, decreased user costs		South Caroline, Oregon, New York, Michigan, Maryland, and Missouri actively use this technique
Best-value bidding	Consideration of both price and quality of proposals		Utah 1-15 design-build, Oregon I-15 lift span bridge
Lane rental	Shorter construction times encouraged, decreased user costs		Indiana I-70, Maine I-295, Oregon U.S. 26
Life-cycle cost bidding	Lowest life-cycle cost of proposals considered instead of lowest construction cost		Michigan M-6, Missouri's seismic isolation system
Incentive contract clauses	Contractors encouraged to meet performance and schedule benchmarks		Michigan M-6 South Beltline
Warranty periods	Encourage quality design and construction, transfer of financial risks to the public sector		Michigan I-75 and M-28 concrete pavement repairs, examples from 24 states DOTs
Intergovernmental Agreements	Resource sharing among agencies, increased efficiency, alignment of local forces with state objectives	Establishing relationships across agencies, identifying win-win opportunities	PennDOT Agility Program
Outsourcing	Lower operational costs, improved quality of services, transfer of risks to private sector, supplement in-house work capacity	Difficulty monitoring performance, availability of accurate data to compare in-house versus outsource costs, labor org. concerns for displaced public employees	MassHighway Maintenance, Virginia DOT Interstate Maintenance, Florida Toll Ways Operations, Florida DOT Turnpike Maintenance Engineering Management, South Carolina Program Management Services
Managed Competition	Same as outsourcing with added opportunity for current work force to improve operations and compete with private sector	Same as outsourcing with added challenge of maintaining a level playing field during procurement	Iowa DOT paint striping and sign shop activities, MassHighway maintenance

7.3.1 MANAGING CHANGES IN THE PROGRAM

If an agency is practicing good asset management, its approved programs support its policy goals and are realistic in light of funding projections. Defined procedures to approve changes in projects and to manage resulting adjustments in programs enable an agency to systematically address unforeseen issues that arise during program delivery and make adjustments accordingly. Managing changes in programs entails:

- Clear guidelines and assigned responsibilities for reviewing and approving project and program-changes.
- Current and accurate project and program data to identify potential problems and anticipate needed adjustments in areas such as the following:
  - Project scope, cost, and schedule;
  - Potential impacts on agency staffing;
  - Availability and sources of funding to cover needed adjustments; and
  - An expenditure plan to analyze impacts on cash flows and to balance revised expenditures to available funds.
- Coordination between project and program managers and between their respective management systems.

7.3.2 DELIVERY TRACKING

Asset management calls for system monitoring and performance results to be applied throughout the resource allocation process. Program delivery performance can be tracked in terms of schedule, cost, scope, and quality. Table 7.2 identifies potential project and program level delivery measures for each of these items. Please see Chapter 5 for a more detailed look at developing performance measures – those concepts also apply to defining and using delivery measures.

Washington State DOT's Management of Program Changes

The Washington State DOT has developed a comprehensive approach to manage program changes during capital program delivery. Highlights include:

***Clear guidelines and responsibilities**: The DOT has documented its protocol and staff responsibilities in a program management manual. The manual defines four project change levels (minor, moderate, significant, and major) and approval requirements for each level. Major changes must be approved by a project screening board, which consists of the Deputy Secretary of Transportation and several assistant secretaries from across the DOT.*

***Current and accurate data**: The Washington State DOT uses a Capital Program Management System (CPMS) to track the status of its capital projects (e.g., start date, planned expenditures, overruns, etc.). Several offices throughout the DOT provide input for the CPMS. The Program Management Office helps these offices understand the importance of their contributions to the process and to submit timely, reliable data.*

***Coordination**: Regional DOT offices enter project-level change requests in to the CPMS. Each night, the CPMS automatically generates a report of these changes. Program managers use this report to review changes and evaluate their subprogram and program impacts. The results of change requests are traced by the CPMS and by the Washington State DOT's Transportation Executive Information System (TEIS).*[21]

Problems with program delivery can often be traced back to one or more of the following shortcomings:

- Poor scoping process (e.g., limited review and scope creep problems).
- Poor costing process (e.g., outdated estimates, oversights).
- Poor scheduling process (e.g., single-project viewpoint, done in isolation, impacts on other projects not considered).
- Poor pre-construction processes (e.g., lengthy environmental permitting requirements, delayed right-of-way acquisitions).

[21] Washington State DOT, **Programming and Operations Manual** (2001). <www.wsdot.wa.gov/FASC/EngineeringPublications/Manuals/P_OManual.pdf>

Measures that are tracked during delivery help agencies quantify performance in these areas and identify opportunities for improvement. For example, final construction costs that consistently surpass initial budgets may indicate a need for estimation techniques to be reevaluated or schedule overruns may indicate the need for improvements in the environmental permitting process. In addition to this diagnostic function, delivery measures provide a means for communicating program delivery status to all stakeholders.

Table 7.2 Examples of Program Delivery Performance Measures

Category	Example Measures
Schedule	Contract milestones (e.g., completion date)
	Project on schedule (yes / no)
	Percent schedule overrun
Cost	Project within budget (yes / no)
	Activity unit cost
	Percent cost increase / decrease
Scope	Number of change orders
	Activities performed versus planned (e.g., lane miles paved)
	Value of projects programmed versus delivered
	Number of projects programmed versus delivered
Quality	Performance specifications for capital improvements
	Levels of service (LOS) for maintenance and operations activities

7.3.3 COMMUNICATING PROGRAM STATUS

The asset management framework presented in Chapter 2 identifies the importance of performance monitoring and constant feedback. The performance measures described above are only effective if they are communicated to decision-makers throughout an agency.

Arizona DOT's Program Status Reports

Effective and timely program delivery is a major priority for the Arizona DOT. Therefore, it establishes 20 milestones for each of its capital projects at the beginning of the pre-construction delivery process. These milestones include anticipated finish dates for various stages of design, completion of technical tasks (e.g., surveying), and obtaining right-of-way clearances. The Arizona DOT incorporates these milestones into a monthly Active Projects Status Reports. This report is used to manage project schedules among DOT staff, design consultants, and other stakeholders. The report is available on the Arizona DOT's web site. Statistics on the pace of program implementation also are submitted monthly to the Governor's offices as one the DOT's key measures of performance.[22]

Effective asset management also requires agencies to be customer-focused. In addition to evaluating the impacts on system users of various delivery strategies, an agency can maintain a customer-oriented approach to program delivery through external reporting. Structuring public reporting requires an agency to identify those aspects of program delivery in which the traveling public has an interest. In addition, communicating delivery status and achievements to the public, legislative bodies, and other stakeholders also will strengthen an agency's credibility and accountability.

Pennsylvania DOT's Agency Report Cards

An example of an effective external communication tool is the Secretary's Report Card, which the Pennsylvania DOT uses to report its accomplishments to the public on a regular basis. Each month, the DOT issues a one page report that explains the importance of a single performance measure and graphically represents its accomplishments in that area. Past reports have included information on the International Roughness Index (IRI), tons of pothole patching material used, and snow removal.[23]

[22] Arizona DOT, **ADOT Project Time Management Guidelines, What's New – Highlights** (2000). <www.dot.state.az.us/about/ppms/guide/GUUIDEREV0.pdf>

[23] Cambridge Systematics, Inc., **Synthesis of Transportation Asset Management Practice**, NCHRP 20-24(11) Task 1 Report (2001). <gulliver.trb.org/publications/nchrp/nchrp_w41_task1.pdf>

7.4 COST TRACKING

It virtually impossible to overstate the importance of valid and reliable costing – both original estimates and monitoring through the course of a program or project. It is difficult to conceive of a major agency decision or initiative that does not include costing as part of its foundation. If the costing turns out to be unreliable, the decision or initiative is often undermined, with potentially disastrous results.

This section describes the types of cost data required to support asset management, identifies common gaps in cost data, and proposes strategies for bridging these gaps. It is assumed that an agency has financial management mechanisms in place (e.g., financial management system able to track expenditures by accounts, manage cash balances and accounts payable and receivable, monitor funds by source and issue required reports, etc.). The following sections focus on how these data relate to the program delivery stage of asset management.

7.4.1 CURRENT SOURCES OF COST DATA

An appropriate suite of infrastructure management systems, complete with accurate and current cost data, would enable an agency to answer the types of questions presented in Table 7.3 with confidence. However, cost data stored in financial management systems (FMS), infrastructure management systems, maintenance management systems (MMS), and bid tabulations are not consistent and not easily integrated. For example, infrastructure management systems track and calculate costs by output (e.g., square yard of asphalt overlay). In contrast, FMS track costs are based on input (e.g., number of labor hours, equipment hours, units of material used, etc.). Therefore, using FMS data to populate infrastructure management system databases is not always straightforward.

Several potential issues arise even when the fundamental basis of cost tracking is consistent between systems. For example, even though FMS's and MMS's both track output-based costs, they track closely related but different aspects of costs. Table 7.4 identifies examples of these differences. The result of these inconsistencies is that comparing projected future maintenance costs generated by a MMS to actual maintenance cost records from a FMS is not an "apples to apples" comparison.

Table 7.3 Cost Data Types and Uses

Application of Cost Data	Example Questions
Relate cost to outcome	What is the impact on overall network performance if we increase or decrease the annual pavement budget by 10 percent?
Identify cost by asset class and / or group of assets (e.g., route, district)	How much do we spend on bridges in Greengrass County? In District 5? How much do we spend annually to maintain I-1?
Estimate costs of project, maintenance activity, or contract alternatives	Is it more cost-effective to relive congestion on a state highway by adding a lane or enhancing operations with an ITS project? What is the cost of using a DB contract compared to our traditional procurement method? How much does it cost to us to maintain our signs? How does this compare to outsourcing alternatives?
Estimate costs of investment strategies)	What is the life-cycle cost of a deferred maintenance strategy compared to that of a preventive maintenance strategy?
Estimate program-level costs	How does the final cost of delivery a program compare to our initial estimates?

Another common gap in cost tracking is the inability to calculate full costs that capture both direct and indirect costs.

- **Direct Costs** – Infrastructure management system cost totals may not account for the direct costs of additional items included in typical project work. For example, pavement project estimates generated by a PMS may not include additional costs for work on ancillary drainage items, guardrail, roadsides, signs, pavement markings, and so forth.
- **Indirect Costs** – Management system costs may not account for indirect work. This work would include, for example, design, construction management and inspection, traffic management and control, and project administration.

Unknowingly underestimating full costs leads to distorted decision-making throughout the entire resource allocation and utilization process.

Table 7.4 FMS versus MMS Cost Tracking Comparisons

	FMS	MMS
Labor	Time sheets	Time sheets or maintenance cards
Wage rate	By employee with all adjustments (e.g., benefits, bonuses, etc.)	Estimated wage rate by employee class or statewide average rate
Equipment	Lump sum at purchase, depreciated over life	As though equipment was rented (e.g., cost/hour)
Materials	Detailed calculations of stockpile costs	Average unit cost

7.4.2 BRIDGING THE GAPS

Improving cost data is often complicated, agency-specific, expensive, and technically challenging. However, the potential benefits of current and accurate cost data far outweigh these impediments. This section presents three general strategies to bridge the gaps in your agency's cost data.

- Populating an infrastructure management system with activity-specific costs based on data from a FMS, MMS, and bid tabulation records.
- Applying an adjustment factor to MMS results so that they are consistent with FMS reports.
- Developing activity-based costs.

The approach that your agency takes to enhance its cost data should be customized based on its specific data needs and the status of its current financial records and systems.

POPULATING MANAGEMENT SYSTEMS

Future cost projections can be improved by populating management systems with data from a FMS, MMS, or bid tabulation records. This approach may require the following steps:[24]

- Identify existing sources of cost data and compile data.
- Identify activity costs required in your infrastructure management systems.
- Map existing data to these data items. Challenges that may arise during this step include:
  - Activities used by your infrastructure management systems may not correlate directly to the pay item codes used in your other systems.
  - Your FMS and bid tabulation records may express costs in different units of measure than your infrastructure management systems.
  - The activity costs in your MMS may not include overhead and indirect costs.
  - An inflation factor may be required to convert historic records to present-day costs.
- Perform a statistical analysis to determine the reliability of the data (this step may include an analysis of cost variation by district).
- Create an expert panel to review the data and make final adjustments.
- Document this procedure and develop guidelines for future updates.

ADJUSTING MANAGEMENT SYSTEM OUTPUT

An alternative to calculating individual activity costs (i.e., management system *inputs*) is to develop an overall adjustment factor that can be applied to system *outputs*. For example, bringing MMS projections in line with actual data tracked in a FMS may require the following steps:

- Define number of adjustment factors. For example, an agency may opt to calculate one statewide factor, urban and rural factors, or a factor for each district. (The remainder of this section describes an approach for calculating a factor for each district.)

[24] John O. Sobanjo and Paul D. Thompson, **Development of Agency Maintenance, Repair & Rehabilitation (MR&R) Cost Data for Florida's Bridge Management System** (2001).

- Calculate total maintenance cost for each district for a given time period using the MMS.
- Calculate the same costs using the FMS.
- Develop an adjustment factor for each district by calculating the percentage of the FMS figure over the MMS figure (it is a general rule of thumb that FMS costs will exceed MMS costs for highway maintenance).
- Identify large discrepancies and investigate possible causes in the agency's business processes.
- Rely on a panel of experts to review factors and make final adjustments.
- Apply the factors to MMS output during future analyses.
- Develop and institutionalize procedures for updating the adjustment factors regularly.

ACTIVITY-BASED COSTING

Activity-based costing (ABC) is an accounting approach common in the private sector that significantly enhances asset management in the public sector. ABC enables agencies to calculate the full costs of its maintenance and operations activities. Knowing these costs, an agency can:

- Accurately evaluate capital, maintenance, and operation alternatives to address a system deficiency;
- Practice activity-based management (ABM) by highlighting activities with specific opportunities for cost savings and operations enhancements; and
- Compare the cost of performing a task in-house to that available through the private sector.

Following is a summary of the process that the Iowa DOT used to develop activity-based costs.[25]

- Define a set of activities that when taken as a whole, encompass the entire scope of work performed by the division.
- Calculate the ***direct labor*** costs required for each activity. This information may be available from timesheets and must be adjusted for time "borrowed" by other divisions and time spent on non-work activities.
- Calculate the ***material costs*** for each activity.
- Calculate the ***facility costs*** for each activity. First, estimate the facility costs for the entire division (e.g., based on the percentage of floor space of a large DOT facility occupied by the division). Secondly, allocate this total among the activities. Facility costs should include a depreciation expense.
- Calculate the ***vehicle and equipment cost*** for each activity. These costs include original cost, maintenance, operating costs, depreciation, and salvage value.
- Calculating the ***overhead costs*** of each activity. Overhead costs include operations, finance, administrative, and oversight costs.
- Determine ***unit cost*** for each activity by combining all of these costs into a full activity cost and dividing by the number of output units.

[25] Mark D. Abrahams and Mary Noss Reavely, "Activity Based Costing: Illustrations from the State of Iowa", **Government Finance Review** (April 1998). <www.state.ia.us/government/ dom/pubs_ presentations/abc_article_pdf.PDF>

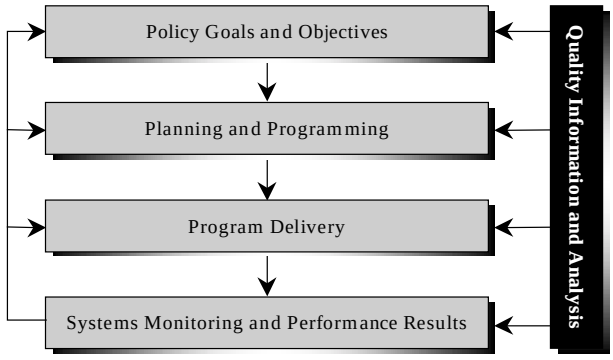
8. INFORMATION AND ANALYSIS

8.1 OVERVIEW

A sound asset management approach requires objective, high-quality data, presented to decision-makers and other stakeholders as understandable, useful information. It is a systems analysis challenge to catalog the many stakeholders and their information requirements, find the simplest analytical and presentation methods that meet as many stakeholder needs as possible, and design data collection processes that efficiently feed the analyses with an acceptable level of quality. In this context, information technology (IT) is a tool to support asset management, not an end in itself.

This chapter provides a management-level overview of the process design issues involved in delivering sound information to decision-makers. IT support of asset management in the broadest sense draws upon wide-ranging expertise in planning, finance, various technical disciplines (e.g., pavements, bridges, traffic, safety) and functions (design, construction, maintenance, operations), business process and work-flow re-engineering, economics, statistics, systems analysis, database management and data integration, software development, and communications. Transportation agencies may already have this expertise in-house or have the ability to procure needed experts from outside. A large body of literature exists in each subject area, of which selected samples are cited in this chapter.

Figure 8.1 Information and Analysis within Resource Allocation and Utilization



There are no comprehensive asset management systems that can satisfy all stakeholder needs off-the-shelf, though there do exist entire competitive industries having effective solutions to parts of the problem (e.g., data collection equipment, pavement and bridge management systems, geographic information systems, and asset inventory systems). Each agency has to decide which commercial systems to buy, which required capabilities should be developed in-house or by consultants, and which capabilities can be used as they already exist. Each agency also has to decide which initiatives to undertake right away and which to defer or to implement in a staged development.

8.2 INFORMATION NEEDS AND DATA QUALITY

Figure 8.2 presents a model for improving an agency's data resources. As with many of the processes discussed in this ***Guide***, this data improvement approach represents a cyclic process enabled by a feedback loop. However, for simplicity, the process is discussed as if it were a linear process starting at the top-right of Figure 8.2, performing an Audit of the Current Situation. Section 8.2 discusses all of the steps through Ensure Data Quality. Improvements to data integration and accessibility are addressed in Section 8.3.

8.2.1 DEVELOPING A DATA STRATEGY

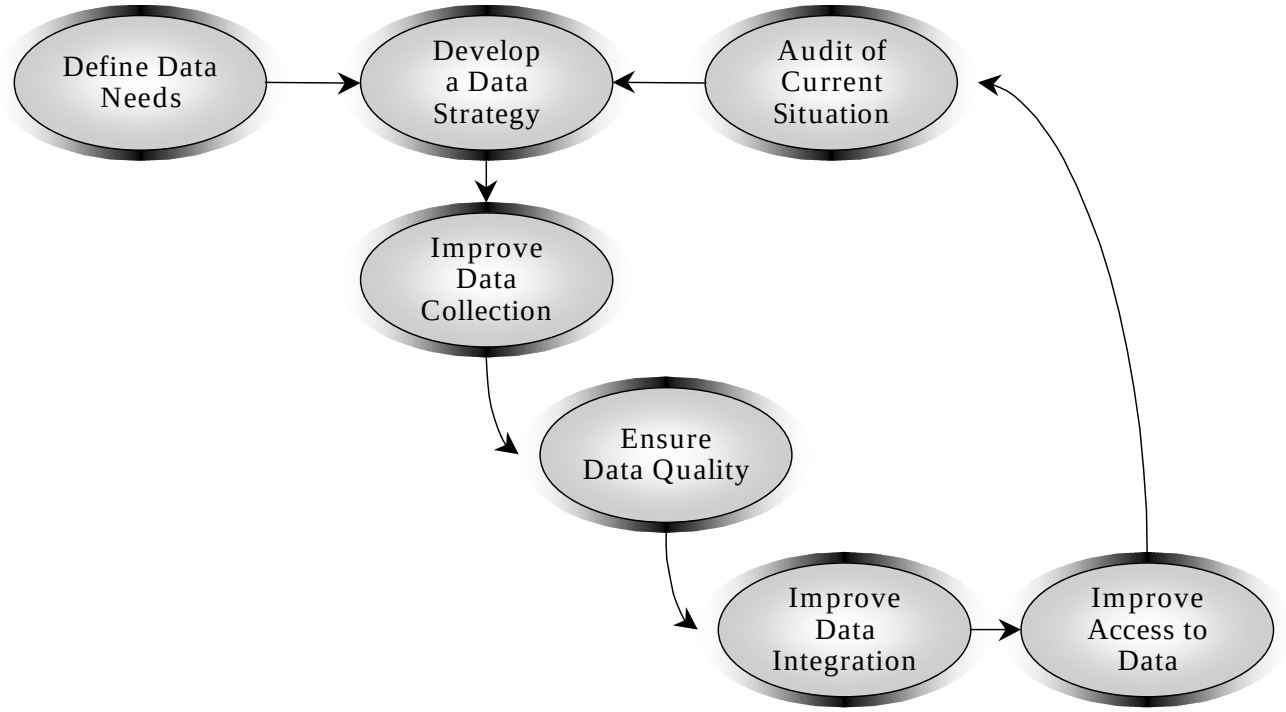
Developing a data strategy requires performing a performance audit of the current IT environment and practices at an agency and defining data needs. The audit will help identify key IT issues that need to be addressed by the data strategy. Areas to consider during this audit include:

- Data that currently is available throughout the agency;
- Data requirements of existing and planned management systems and decision-support tools;
- Data collection and maintenance costs; and
- The value (real and perceived) of data for decision-making.

The results of the IT audit will feed into the identification of data required to implement and support an agency's transportation asset management functions. These decisions depend upon the scope of asset management and the particular business processes conducted by the agency, as discussed in Chapter 4. The example requirements below

provide guidelines for identifying data items required to support asset management. Individual agencies should tailor these examples to their particular practices and system objectives, and may choose to develop requirements in more detail to relate to specific business process, system, and data characteristics.

Figure 8.2 Data Improvement Model



ASSET INVENTORIES

- Inventories for different asset classes should be based on a common location-referencing scheme. This standard allows for queries of which assets are present in a given location or network segment, and provides a unified basis for data input, display, and reporting.
- A common set of geographic descriptors and classification categories for summarizing information should be supported across asset types – e.g., districts, corridors, functional classes, responsible agency for ownership and operation, climatic or topographic zones, and so forth.
- The coverage and detail of inventory data for each asset class and type[1] should be established at a level that is appropriate to the scale of investment required for that class, business process requirements, and data collection costs. Choices include, for example, use of a sampling approach versus 100 percent coverage; annual updates versus less frequent surveys; and identification of specific items at individual locations versus aggregate counts within intervals or segments.
- The inventory should include sufficient information on asset characteristics and classifications to support the full range of asset management business processes, including condition assessment, GASB financial

[1]For example, if "pavements" and "hardware" are asset classes; "flexible pavement" and "signs" would be asset types.

reporting of infrastructure assets,[2] needs analysis, and project prioritization. A strategic overview of transportation assets is needed to define an inventory of appropriate structure and detail, with standards of precision, accuracy, and timeliness of data collection that meet these varied needs.

- While there may be separate inventories for each class of asset, commonly used data (such as functional classification and AADT) should not be collected more than once. If individual systems require the same kind of information, but in different formats, or at different levels of detail, then automated methods should be established for deriving the necessary information from the primary source.

CURRENT ASSET CONDITION AND PERFORMANCE

- For each type of asset, at least one objective measure of condition should be collected and stored.
- Ideally, historical condition data (possibly in aggregated form) should be maintained and made accessible to support trend reporting and analysis.
- In addition to purely technical condition indicators (e.g., pavement roughness, sign visibility or reflectivity, and percent items deficient), other measures that are useful for policy-making and reflect customer perspectives should be collected and stored. Examples include composite condition or serviceability indexes, customer satisfaction ratings, and measures of user cost or benefit are useful for policy-making and reflect customer perspective.

COST DATA

- Cost data should account for the full costs of an activity; accounting for indirect as well as direct activities. Construction and maintenance cost information should be compiled so that a time-series of costs can be derived: e.g., by work type, asset type or asset class, location and network classification.

PROGRAM DELIVERY INFORMATION

- Maintain records of actual costs and time of completed projects, including significant changes
- Program outcomes in terms of established performance measures

8.2.2 MAXIMIZING DATA COLLECTION AND DATA MANAGEMENT EFFICIENCY

EXISTING TECHNICAL CAPABILITIES

A major source of simplification and economy is to take advantage of existing data collection processes, systems, and standards. A transportation agency has many opportunities to do this. Here are just a few examples:

- Agencies can take advantage of commercial off-the-shelf systems for storing and managing asset data (e.g., commercial database applications, querying and reporting applications). Bridge, pavement, and maintenance management systems are now used by most transportation agencies for this purpose.
- Several firms offer to sell, lease, or operate automated data collection equipment, including pavement survey vehicles, truck weight and dimension measuring equipment, and bridge monitoring devices. Taking advantage of this technology is often less expensive than performing similar functions manually.
- Often data collection equipment or procedures can be applied to multiple purposes. For example, pavement management survey vehicles can inventory and videotape roadside features, measure obstructions, and record information about capacity and access. These data can be used by other units in a DOT: e.g., for safety, geometric design, maintenance, etc. Bridge inspection processes can record traffic safety features and speed restrictions at bridge sites. Crash data can be mined to analyze vehicle occupancy.

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[2] GASB refers to the financial accounting and reporting standards issued by the Governmental Accounting Standards Board. Many of the references to GASB in the system requirements listed in this section will apply only if the modified approach is used for financial reporting.

Virginia Inventory and Condition Assessment

The Virginia DOT has developed a comprehensive Inventory and Condition Assessment System (ICAS) to facilitate the management of the extensive assets associated with the Commonwealth's highway and road networks. The system employs state-of-the-art automated data collection and precise global positioning technologies. The purpose of the system is to provide an accurate inventory of transportation system assets, determine and record their condition, and locate them geographically using global positioning satellites. This information is loaded into a relational database to provide tools for decision makers to get a near real-time picture of the state of their transportation network and assist in effective, responsive planning and the most efficient allocation of scarce resources. ICAS provides the foundation for the statewide asset management system.

When ICAS is fully implemented, VDOT can use this system to immediately access information about any asset, including lighting, signs, guardrails, traffic control devices, and drainage, to determine exact location and condition to ensure effective and efficient maintenance and safe operation of the roadway network. The capability to access spatial information also allows decision makers to visualize the situation and take appropriate actions in case of natural disasters or damage by vehicles to the roadway network. Since the requirements can be identified quickly, work efforts can be prioritized efficiently to ensure the most critical requirements can be satisfied first, gaining the most effective results from constrained resources and workforce to meet the public's transportation and safety needs. This system also provides ready access to vital information for long range planning, budgeting, and resource allocation. In addition, the database provides an efficient storage medium for historical information that might have been lost in the past as experienced personnel relocate or retire, ensuring continuity of operations.

The data collection system employed in the initial three-county pilot effort consists of three key elements: 1) field collection using inspectors with backpack-mounted computers, voice recognition software, and global positioning equipment; 2) van mounted data and digital image collection systems; and 3) asset collection from digital and orthographic images. The data collected are then used to build an asset inventory and develop roadway centerlines (geometric data).

Field collection using backpacks and a voice recognition system was highly innovative and effective. It allowed inspectors to establish accurate geo-referenced location, compile a detailed inventory, and assess condition. All of this information was collected and entered into the database "hands-free," allowing effective and safe data input. This method also allowed collection and assessment of highway assets such as pipes and drainage that are not visible in ground-based imagery or digital orthophotography.

In areas where it was not safe or impractical to accomplish field collection, inspectors used the van collected digital images to obtain and record asset data/information. Lastly, some information, such as ramps and loops, was collected directly from orthophotographic images. All of this asset information was merged with the field data and entered into the central database.

In conjunction with this effort, VDOT contracted the collection of right-of-way images and development of roadway network centerlines. This was a significant element of the project because it develops roadway centerlines for the entire statewide network, including interstate, primary, and secondary roads. this information will also be entered into the database.

The central database employed in this project is a relational database that allows VDOT to access needed linear-referenced inventory and condition assessment information to enhance effective and timely planning, decision-making, and resource allocation by the various offices and districts in VDOT responsible for the effective, efficient, and safe operation and maintenance of the state's highway and road network.

- Global Positioning System (GPS) equipment is becoming widely used to pinpoint the locations of road segments, structures, and roadside features. A single GPS survey should be able to satisfy the needs of all types of assets, as well as recording speed limits, traffic direction, number of lanes, route connectivity, and other geographic network information about the infrastructure.
- Maintenance crews typically have to fill out timesheets, and contractors have to report work they have accomplished. These activities can be augmented to record data necessary for estimating quantities and costs to improve planning models. GPS equipment on maintenance vehicles can help to ensure the accuracy of this information.
- Data collection processes done by in-house staff require training and standardization. Agencies can take advantage of industry standards, which help improve the quality and lower the cost of data collection. For example, AASHTO has new standards for pavement management data collection. In addition, pooled efforts can be used to spread the cost of

developing training and quality control procedures.

There may be a disadvantage of using existing procedures and equipment for a new data collection need, in that the existing method may not be fully adaptable to the new requirements. For example, when an agency decides to adopt an off-the-shelf pavement management system, it typically has to choose between living with the existing database architecture even if it is not an exact fit to the agency's needs, or foregoing compatibility with future enhancements that may be provided by the vendor. It may be possible to build a software "shell" or "adapter" around an off-the-shelf system that tailors the system more closely to the agency's requirements.

SAMPLING TECHNIQUES

Another way to economize in data collection is to use sampling. Sampling is a powerful tool for certain applications, but it also has distinct limitations. In an inventory where each individual facility is significant and failure of any one could be catastrophic – bridges, for example – sampling may not be appropriate in certain applications. Even in bridges, however, sampling can play a role: for example, estimating the severity of chloride contamination of bridge decks is done by taking samples scattered over the deck surface.

Effective Use of Sampling

Sampling is often used when the data are representative and where the consequences of not observing every facility are not catastrophic, or where a backup process is in place to detect serious problems. One common example is the measurement of sign cleanliness and reflectivity. Many agencies check a random sample of signs periodically to gain a statistical indication of sign condition. The backup process is the watchfulness of local maintenance supervisors, who are expected to report individual cases of missing or obscured signs.

Sampling also may be used to exploit a cause-and-effect relationship to estimate a difficult-to-measure variable from sampled data, using one or more variables that are easier to measure and have larger or exhaustive samples. For example, a strategy to predict costs in pavement or bridge management systems might involve three stages:

1. Start with an exhaustive sample of condition data from ongoing data collection processes, showing the extent of deterioration on each facility.
2. From a relatively large sample of work accomplishment data, estimate the quantities of various kinds of work required (e.g., pay items or bid items) as a function of the deterioration quantities and other relevant variables.
3. From a smaller sample of work records, estimate the unit costs of the pay items and bid items.

This three-level approach recognizes the fact that the extent of deterioration is readily available for all facilities, but quantities of work are less accessible, and accurate costs are less accessible still. Recent work in developing unit costs for bridge management systems uses approaches like this.[3]

8.2.3 ENSURING DATA QUALITY

Quality assurance is an ongoing process, using system design, statistical methods, training, and auditing to maximize various attributes of data that together we know as quality. Quality is not free, but the expense of quality assurance does tend to pay for itself later.[4] For example, increased quality of bridge inspection saves the expense of sending crews to a bridge site for repairs that turn out not to be needed, or setting up emergency repairs on a bridge where an existing problem had not been detected.

Measurement of quality begins by identifying several important attributes, and determining their importance to the end result.

- **Accuracy.** Data are accurate when repeated measurements cluster around the "true" value of what is being measured. Accuracy is determined by performing occasional check

[3] Sobanjo, John O., and Paul D. Thompson, *Development of Agency Maintenance, Repair, and Rehabilitation Cost Data for Florida's Bridge Management System*, Final Report, Florida Department of Transportation , 2001 (available on www.pdth.com/images/fdotagcy.pdf).

[4] Crosby, Philip B., *Quality is Free: The Art of Making Quality Certain*, McGraw-Hill, 1979.

measurements using a more accurate (but probably more expensive or scarce) tool.

- **Precision.** Data are precise when repeated measurements are tightly clustered around the same value, whether or not it is the "true" value. GPS measurements, for example, are more precise than locating an object on a map.
- **Coverage.** The extent of coverage of a data set is a key design decision and a key limitation on its usefulness. An inventory of state highways, for example, is of no help to project-level needs identification for local roads.
- **Timeliness.** Timeliness refers to the age of data at the time they are used. Timeliness must balance several competing requirements: e.g., the appropriate point or season of the year in which to conduct inspection surveys; the need to process data for use in management system(s); and the need for the resulting information by one or more organizational units in assessing current condition, comparing actual to planned accomplishments, identifying work needs, developing a program budget, and so forth.
- **Detail.** Appropriate level of detail is an application-specific requirement that is often a matter of definition. PMS and BMS need unit cost data at a level of detail that matches the definitions of treatments that their models can analyze.
- **Accessibility.** This attribute of data quality refers to the ease with which the data can be put to use. Weigh-in-motion data, for example, are an excellent resource for truck weights, but are often useless unless processed to the needed level of detail.
- **Assumptions and Definitions.** Data sources may have definitional differences or inherent assumptions that make them more or less useful for asset management applications. For instance, definition and interpretation of pavement condition data may differ between an agency's PMS and MMS.

QUALITY STANDARDS

When two or more information systems share the same data source, it is important to have a formal, documented quality standard, describing minimum and maximum requirements along all the dimensions noted above, that meet the needs of the stakeholders using the systems. This serves as a multi-way agreement among the end-users, data collectors, and system developers, an agreement that should not be modified without again involving all these stakeholders. Upper managers do not have to be involved in developing these standards, but they do need to insist that the standards are developed.

Data quality standards are an essential management tool: they are directly connected to budgetary requirements for data collection, and they provide a streamlined way for upper management to ensure that conflicts regarding data quality are resolved. With this tool, a manager responsible for a data collection budget can express the impacts of budgetary increases or decreases in terms of changes to the data quality standard, and their effect on specific end-users.

QUALITY ASSURANCE

Quality assurance (QA) processes require a context of documented standards, and they are the mechanism by which adherence to standards is measured. Senior managers are not typically involved in quality assurance personally, but the existence of QA processes, and periodic effectiveness measures, are what provide managers the needed control and assurance. The first point of quality assurance is the training of data collectors and equipment operators.

Data Collection Training

Bridge inspectors have at least two weeks of formal training, often much more, including classroom and field work. They are then tested and certified. To maintain certification, they must take refresher courses and be re-tested periodically. Although it is possible to create training courses in-house, it is often far more cost-effective to use externally-developed courses, even though this may mean changes or limitations on data quality standards. The National Highway Institute offers a variety of courses, including bridge inspection, and manufacturers of data collection equipment often offer training.

Quality assurance with respect to use of fully automated data collection equipment includes defining standards for measurement, planned equipment testing and certification, and applying calibration procedures prior to surveys and verification of calibration following surveys.

After data are collected, a number of methods are available to measure adherence to the quality standards. These include re-inspection strategies, consistency checks, stakeholder surveys, and formal data audits.

RE-INSPECTION

It is a standard procedure in any sizeable data collection process to devote a portion of the resource, often five to 20 percent depending on the consequences of error, to re-collect a sample of data using similar or better equipment and/or personnel. For example, after a section of road is completed with a pavement survey vehicle, an agency might use an alternative vehicle, a different crew, or even profile measurements made by land surveying equipment, to double-check the initial data. Locations for the re-check are typically chosen by random sampling, and statistical methods are available for deciding how many locations to check[5]. The results of these checks are tracked over time as a performance measure. Sometimes crews compete and are rewarded according to the results of the process.

CONSISTENCY CHECKS

Often data sets have built-in redundancy. For example, a roadway inventory may have the number of lanes, lane and shoulder widths, and traveled way width. An automated process could easily identify discrepancies needing evaluation. A well-designed information system should be able to perform these checks automatically, and flag potential problems for later resolution. The ability to resolve such problems at a later time is important, since it may have to wait until the next data collection cycle or until someone can be dispatched to visit the facility. After resolving the issue, it should be possible to record an explanation and turn off the flag even if no correction is warranted. The number of such errors in newly collected data, and their resolution status, should be tracked as a quality measure.

STAKEHOLDER SURVEYS

For certain attributes of quality, it is efficient to ask stakeholders to report the level of quality they perceive in the information they receive, including their level of satisfaction. Although stakeholders generally can not easily measure accuracy (except anecdotally) or precision, they can often uncover problems with coverage, timeliness, detail, accessibility, and definitions.

DATA AUDITS

Occasionally it is useful to employ an outside agency or consultant for an independent review of data quality, especially if the consequences of incorrect information are dire. In bridge inspection, for example, it is common for districts within a state to swap inspectors periodically to give a fresh perspective. The FHWA, an important user of bridge data, conducts regular audits of states' bridge inspection practices.

It is very important for senior managers to recognize that data quality for asset management is relatively easy to define using the approach described here, and is highly measurable at reasonable cost. For each data item (or group of items) in an asset management database, it is reasonable to identify, along with the source of the data, the quality control process that ensures that the data will be sufficiently accurate for its intended use, according to all relevant quality dimensions. Doing this in an organized way is less expensive and more effective than an ad hoc approach, and certainly less expensive than the consequences of poor decisions that could result from incorrect or insufficient data.

8.3 DATA INTEGRATION AND ACCESSIBILITY

Data integration is a set of processes and systems to share data from one source among multiple applications, or to merge data from multiple sources for use by a single application.[6] As agencies have applied several maturing information systems related to asset management over the past 20 years, they have come to recognize more widely the importance of data integration. However, competing philosophies and technologies have led to a wide range of alternative approaches. For those wishing a more detailed description of data integration approaches,

[5] Cochran, William G., *Sampling Techniques*, Wiley, 1977.

[6] Management System Integration Committee (MSIC), *The Integration of Transportation Planning Information*, Federal Highway Administration, 1998.

the FHWA has published a *Data Integration Primer*.[7] In addition, the FHWA is sponsoring an in-depth review of current data integration practices and their application to transportation asset management. This project is scheduled for completion in 2003.[8]

8.3.1 BENEFITS OF INTEGRATION

The benefits of integration are clear:[9]

- Provide more thorough information that yields a more accurate picture of what a manager is managing. Effective integration matches available data to each user's responsibilities.
- Help coordinate management functions across departmental units (e.g., among construction, maintenance, and operations regarding proposed road closures).
- Allow existing data collection processes and information systems to serve new applications they were not originally intended for. For example, the outputs of several asset management systems can be brought together for integrated programming and budgeting applications.
- Make data more understandable by having standardized definitions and measurement techniques and units across the agency.
- Reduce data collection cost by avoiding duplication of effort and making more efficient use of expensive data collection equipment and technical personnel. Data collection and associated database management can have significant economies of scale.
- Make systems and results consistent by using the same data sources.
- Make quality assurance processes as manageable as possible.
- Make multiple data sets accessible for comparative, analytical, and reporting purposes by linking the data electronically.
- Enable applications that may be important but have too narrow an audience to justify their own data collection processes.
- Improve communications by making data presentations more intuitive and complete.

8.3.2 APPROACHES TO INTEGRATION

While current infrastructure management systems provide many useful capabilities, they are not widely integrated, and may not meet all of the analytic and reporting needs of an agency's desired asset management approach. Areas where better integration may be considered are as follows:

- **Data collection, processing, and storage –** Efficiency can be gained by using data collection techniques that serve multiple business areas and associated IT applications: e.g., customer satisfaction surveys that cover a wide range of topics, collection and processing of a single set of traffic statistics, and use of pavement survey vehicles that collect data for pavement, traffic, safety, and maintenance management. Analyzing and storing data in an integrated fashion avoids data duplication or conflict, provides a consistent basis for analyzing infrastructure usage, condition, performance, and related user benefits, and promotes data integrity.
- **Queries of asset conditions, needs, and planned projects** – The capability to access information – e.g., on infrastructure characteristics, conditions, deficiencies or needs, and planned projects – using a flexible, easy-to-use query feature allows for custom reports and rapid responses to management questions. Combining this feature with a map display provides a useful visual tool to identify problem locations and proposed solutions.
- **Consistent evaluation framework in analyzing projects and programs** – Even though different types of projects and classes of assets may need to be analyzed using specific engineering and economic methods, a common framework provides a basis for evaluation and investigation of tradeoffs. This framework

[7] FHWA, *Data Integration Primer*, Office of Asset Management, August 2001.

[8] Contract DTFH61-01-C-00181, managed through FHWA's Office of Asset Management.

[9] Several of the following benefits and drawbacks of data intergration were discussed in NCHRP Report 363, *Role of Highway Maintenance in Integrated Management Systems*, Chapter 3, 1994.

might entail, for example, use of a life-cycle cost approach to project evaluation where appropriate, and common measures of cost, benefit, and performance that allow for comparisons across project types and asset classes. The framework also should promote consistency in technical assumptions such as discount factors, value of time, accident cost, and so forth.

- **Improved *decision support* in the following areas**:
  - **Executive Information –** System capabilities and tools that are specifically designed to provide policy-level information are needed to better support executives and managers needing a "big picture" view.
  - **Tradeoff Analysis** – Methods are needed to assist with tradeoff analysis across asset classes, program categories, and types of investment, making use of comparative analyses of costs, benefits, and performance measures.
  - **Benefit/Cost Analysis** – Benefit/cost analysis provides a useful, commensurate basis to evaluate different categories of candidate projects. When structured in a life-cycle cost context, it provides an economic framework for analyzing capital-maintenance and capital-operational tradeoffs.

GIS as a Platform for Integration

New York State DOT now integrates its pavement management and bridge management information on a GIS platform as part of its asset management development. A typical display shows a map with the highway system, on which are superimposed color-coded symbols indicating pavement or bridge projects, respectively. Double-clicking on a project symbol opens a window displaying detailed information on the project. An analogous approach is now under development in Michigan DOT and Arizona DOT, and is proposed in CDOT. MDOT has compiled a unified data repository, ADOT is designing and developing a data warehouse, and an extension of CDOT's data warehouse to asset management is now proposed. These data warehouses will consolidate asset inventory information and potential project information from asset management systems, communicate with a GIS to display asset information spatially, and generate management reports efficiently, including reports designed and formatted for higher-level management.

The best model to use for improving data integration can vary by agency and therefore should be considered on a case-by-case basis. Similarly, the actual cost of each strategy will depend upon the specific situation at hand. It is possible to stage the migration of data to provide near-term improvement while planning for longer-term redevelopment.

8.3.3 IMPROVING ACCESS TO INFORMATION

Most states employ asset management systems: particularly for pavements and bridges, but also for safety, public transit, intermodal facilities, other system features and appurtenances, construction projects, maintenance, and traffic operations. Surveys conducted by NCHRP[10] and the FHWA[11] indicate that these systems are widely used for technical and research purposes, including detailed program

[10]Lance A. Neumann, *Methods for Capital Programming and Project Selection*, NCHRP Synthesis 243 (1997).

[11]Edgar P. Small, Terry Philbin, Michael Fraher, and George P. Romack, *The Current Status of Bridge Management System Implementation in the United States*, International Bridge Management Conference, IBMC-043, Transportation Research Board and Federal Highway Administration, Denver CO (April 1999).

development. However, their use by higher-level or executive management for decisions such as resource allocation and program tradeoffs is much less frequent. Initiatives in asset management and compliance with GASB Statement 34 will likely change this outlook. Several state DOTs have already made efforts to provide wider access to the information required to support their business processes. For example, WSDOT has for several years successfully employed an executive information system that provides high-level programmatic and financial information to WSDOT managers, legislators, commission members, and staff. WSDOT's maintenance levels of service are likewise implemented in this executive-level system, complete with color photographs illustrating each level of service within a maintenance program area. Users can apply the system to explore budget implications of changes in level of service within each program area. Michigan DOT has been contemplating to build such a system upon its existing asset management applications. NYSDOT's maps of its high-level program performance measures (discussed above) also are an effective illustration of information tailored to executives.

8.4 DECISION SUPPORT

8.4.1 OVERVIEW

At any level of maturity, a transportation agency with a bona fide asset management process uses the data it collects in some productive way to make better-informed decisions. As the process improves over time, decision-makers and other stakeholders gain increased trust in data quality, and garner more usable and capable tools for accessing and presenting information. At some point, decision-makers reach the limits of utility that presentation tools can offer, and need more sophisticated tools in order to exploit their valuable data resources to further improve decision-making. Decision-support tools serve several important purposes:

- They digest a large amount of input data into a much smaller and more focused set of information needing immediate attention;
- They convert data collected according to the definitions and norms of engineers and data collection staff, into terms and concepts more familiar and useful to managers;
- They provide an economic perspective on facility conditions, and calculate performance measures in a form compatible with the agency's objectives, uniformly across all asset types;
- They predict the future outcomes of decisions under consideration; and
- They express decisions and predicted outcomes at the level of detail and coverage appropriate to each specific decision-maker.

Agencies already have considerable IT capabilities supporting transportation asset management. All states have, at a minimum, two basic pools of data: one associated with FHWA's Highway Performance Monitoring System (HPMS), which provides information on geometric, structural, and operational condition for a sample of roads; and the second required by FHWA's National Bridge Inspection (NBI) Program. Most DOTs, however, have more extensive highway inventories and periodic inspection and condition assessment programs. Inspection survey data for assessing the physical condition of infrastructure are obtained through a variety of techniques, including drive-by visual observation, detailed site inspections, non-destructive testing, automated vehicle measurements, and photo- and video-logging. Operational data describing real-time conditions of the transportation system are likewise obtained through a number of technologies, including cable or loop detectors and cameras for monitoring traffic flow, speed, and vehicle characteristics, and sensors for monitoring road surface temperature and precipitation. These data are used in systems to manage infrastructure, as described in Figure 8.3, and traffic operations and safety, as listed in Figure 8.4. Figures 8.5 and 8.6 identify systems that, while not addressing infrastructure specifically, play important roles supporting asset management.

Figure 8.3 Typical Infrastructure Management Systems

Infrastructure Management Systems
Pavement Management – Nearly all states have pavement management systems (PMS). Experience with these systems over several decades has led to a high degree of refinement regarding information organization and content and decision-support procedures. These systems generally have capabilities for maintaining and reporting the status of the pavement inventory, current and historical condition, forecasts of performance for assessing future needs, guidance on project and program development, and actual performance of pavement parameters (e.g., materials, structural design, mix design, etc.) in such applications as Superpave and the new AASHTO 2002 mechanistic design.
Management of Bridges and Other Structures – Bridge management systems (BMS) have well-developed data, analytic, and reporting capabilities for bridge structural and operational condition. Some states have employed BMS to represent other structures such as high-mast light fixtures, sign bridges, and minor tunnels. However, this practice is not standardized, and additional systems development may take place to address these and additional structures (e.g., retaining walls, ITS installations) more specifically. The FHWA, in partnership with the Federal Transit Administration (FTA), recently completed the development of a Tunnel Management System for highway and transit tunnels.
Maintenance Management – Many states have a maintenance management system (MMS) in place. The original uses of these systems were to record information on maintainable highway features, plan and schedule maintenance activities, and estimate budgets and resource requirements based upon standardized, statewide work-requirement factors. Recently several DOTs have enhanced their analytic approach to maintenance management to develop level-of-service or performance-based methods for maintenance budgeting, bringing MMS closer to the concepts used in PMS and BMS. More integrated MMS are on the horizon that will link maintenance management with other DOT functions in transportation asset management, financial management, resource management, and construction project management.
Other DOT-Maintained Facilities and Features – While many agencies employ their maintenance management systems to monitor condition of facilities (e.g., rest areas) and features (e.g., guardrail, signs, and signals), some agencies have developed individual management systems to maintain more detailed information on these items.
Other Modal Facilities – The application of IT to assets of other modes is more varied among DOTs, due to different program responsibilities and levels of budget that DOTs exercise among transit facilities, aviation and maritime facilities, pedestrian ways and bicycle paths, and intermodal facilities such as park-and-ride lots and stations. Transit routes, pedestrian ways, and bikeways that are part of the highway network may be designated within a highway database or maintained in a separate system or database, while individual modal and intermodal facilities may be addressed by a separate IT application. A complicating factor is that modal responsibilities may be vested in more than one agency, in which case the DOT's role is associated, for example, more with program funding and monitoring than with line management responsibility. In many cases a DOT's role in these other modes, and consequently its IT applications, may focus more on operational rather than infrastructure concerns.

Figure 8.4 Typical Management Systems in Transportation Operations, Safety, and Customer Service

Transportation Usage and Customer Services
Highway Usage, Operations and Safety – All states maintain data on traffic (at a minimum, annual average daily traffic or AADT), and accidents by location, though the level of detail and sampling strategy varies. Some states have capabilities in place such as traffic operations centers to track more detailed operational characteristics (e.g., congestion patterns, speeds) for particular facilities.
Congestion, Safety, Public Transit and Intermodal Management Systems – The degrees of implementation and the operating characteristics and scope of these systems vary among agencies. The most sophisticated treatments of these topics occurs in traffic operations centers, which monitor traffic speed and congestion in real time, and with ITS installations, which, among other technologies, employ real-time monitoring and information feedback to the traffic stream (e.g., through variable message signs).
Transportation Network Planning Models – Most transportation agencies have basic trip generation, modal split, and traffic assignment modeling capabilities in place to forecast future transportation movements, with associated data: e.g., trip origin-destination tables and network characteristics (distance, speed, travel time, cost). These models are used primarily at the regional level, though a number of statewide models also are in use. DOTs also may track demographic data that influence demand for, and impacts of, transportation: e.g., population, employment, socioeconomic characteristics, and travel patterns. Some states have freight as well as passenger travel information.
Customer Information – Some states maintain data on customer perceptions of service quality that are obtained via surveys. Event tracking systems also are used by some DOTs to log customer questions and comments, initiate any needed work orders, and manage the closure of each item.
Real-Time Weather Information – DOTs in winter climates that may lead to freezing temperatures on pavements and snow and ice precipitation may monitor weather conditions in real time. These systems employ sensors that report air and pavement temperature and precipitation on the road surface as they occur. These monitoring systems may be combined with weather forecasting capabilities that apply data on local site conditions within area meteorological models to forecast weather conditions affecting roads.

Figure 8.5 Typical Systems to Manage Agency Resources

Agency Resources

Accounting and Financial Management – DOT systems for comprehensive accounting and financial management are central to tracking and reporting departmental funding and expenditures by program. They document funds expended by program, organizational unit, work task, and type of expenditure, supporting asset management in several ways: e.g.,

- They enable tracking of historical trends in revenues and expenditures, which can be correlated with major program changes and influencing factors.
- They enable agencies to identify the full costs of building, operating, maintaining, and rehabilitating transportation infrastructure, and to compare the costs of different methods of program delivery.
- They define the "ground truth" for dollars received and spent as a reference for other management systems. Program costs calculated by other systems (e.g., PMS, BMS, MMS, equipment or materials management, construction project management) can be reconciled against financial system data.
- They can identify the costs of responding to extraordinary or non-typical situations (e.g., emergency and disaster response, major interdistrict transfers of resources, and special applications of program funds).

Human Resource and Payroll Management – Agencies have systems to manage employee information and payrolls. Human resource data back-up line managers' assessments of the availability and cost of in-house staff to deliver products and services, influencing decisions on feasible methods of program delivery. Information on labor skills and costs by organizational unit can be applied within integrated maintenance management systems to provide more precise tracking of activity accomplishment as well as single-source input of labor time reporting.

Maintenance Resources – MMS are the primary tool for scheduling and managing maintenance resources across organizational units and for comparing methods of delivery (e.g., in-house labor forces versus outsourcing). They do not, however, track labor usage and costs to the same precision as that employed in human resource systems, payroll systems, and financial management and accounting systems. Moreover, their costing of equipment in terms of simple "rental" rates based on usage (e.g., by hour or mile) and of materials in terms of essentially a unit cost may only approximate the more precise calculations used in other systems.

Equipment and Materials Data – Agencies may track information on heavy equipment (as for construction and maintenance) and materials through financial system modules or via specialized equipment and materials management systems designed specifically to reflect agency purchasing and accounting conventions. These systems incorporate algorithms that meet an agency's specific approaches to cost assignment and accounting: e.g., depreciation or estimation of rental charges for equipment, and stockpile or inventory calculations for materials.

Real Estate and Property Data – Agencies may employ specialized systems to manage right-of-way holdings and acquisitions, as well as buildings and properties ancillary to the transportation network (e.g., maintenance yards, garages for DOT equipment).

Figure 8.6 Typical Systems to Manage Programs and Projects

Programs and Projects
Planning and Programming Information – Agencies often support planning and programming procedures and STIP development with IT applications identifying the status and characteristics of candidate projects. These systems organize project information within a time horizon, typically 10 to 20 years for planning, six to 10 years for mid-range investment plans, and three to six years for programming. Data usually include project identification by program, proposing agency or division, estimated cost (total or by phase: preliminary engineering, right-of-way acquisition, and construction), planned years of phased implementation, and funding sources. This information may be printed and incorporated as part of a DOT's long-range plan, its statewide transportation improvement program (STIP), and other agency planning and programming documents.
Project Pipeline and Construction Management – Agencies also may maintain information on construction projects in various phases from preliminary engineering to completion. Project pipeline systems address project status following approval of the STIP and the annual/biennial construction program, as projects move into design, right-of-way acquisition, environmental evaluations, and permitting prior to advertisement of bids ("ad date"). Construction management systems address project implementation following opening of bids and construction contract award, through to project completion and closeout. Project milestones, critical events affecting progress, and payments to contractors are tracked. Approved changes in the scope, cost, and schedule of each project also are recorded.
Bid Costs – Many agencies track the cost of construction projects in terms of a standardized list of bid items and associated unit costs. Each advertised project that includes a particular bid item contributes a paired data point in terms of the unit cost submitted by the winning bidder and the specified quantity of the bid item. At the end of the year the weighted-average unit cost of each bid item is computed from these accumulated data pairs; the unit costs of all bid items are published or maintained in a database. Data may be computed statewide or by geographic unit such as district or county. These data provide guidance to engineers on current bid prices, reflecting trends in labor, equipment, materials, and subcontractor costs and the local bidding climate.

8.4.2 SAMPLE INFORMATION SYSTEM REQUIREMENTS

INFORMATION SYSTEM REQUIREMENTS

This section provides several examples of information system capabilities that support the resource allocation and utilization process illustrated in Figure 8.1. The organization of these examples is consistent with the organization of the data needs presented in Section 8.2. Individual agencies should view these examples in the context of their individual practices and system objectives, and may choose to further investigate capabilities that are highly relevant to their business processes and inline with their existing suite of management systems.

CURRENT ASSET CONDITION AND PERFORMANCE

- Systems or analytic tools should be able to derive values of established agency performance measures from raw condition data in an unambiguous and replicable way (e.g., to compute a cracking index as a function of type, severity, and extent of cracking). If the condition measures or indexes are used in the financial reports of infrastructure, they should conform to GASB 34 standards.
- Systems should support queries of individual asset condition and of aggregate condition measures, composite measures, and combinations of measures, by location and asset class or type.

PROJECTED ASSET CONDITION AND PERFORMANCE

- Systems should provide the capability to project future asset condition: e.g., using asset deterioration models. Ideally, the system will be able to apply actual data from condition monitoring to automatically update these deterioration models.
- Systems should provide the capability to project future values of established agency goals, objectives, or target performance measures.
- Systems should project condition in relation to a target condition level, also referred to as scenario testing (refer to the example on the following page).

COST ESTIMATION AND REPORTING

- Systems should utilize models to estimate costs of key activities in transportation asset management, particularly for projects to build, repair, rehabilitate, and reconstruct infrastructure, and for preventive and routine maintenance. To the degree possible and appropriate, these models should try to achieve the following criteria: accounting for the full costs of an activity (refer to Chapter 7 for more details on cost tracking); distinguishing between constant- and current-dollar estimates; clarifying the basis of the cost estimate (e.g., operating costs of equipment in maintenance management systems; depreciation of equipment in equipment management systems); using actual unit costs in lieu of statewide averages; conforming to GASB standards on cost reporting, even if the modified approach is not planned for use; and providing an option to account for ancillary costs (e.g., benefits on labor costs; costs of construction inspection and management as adjustments to project costs; replacement of appurtenances as part of a construction project).
- In addressing critical assets such as bridges, systems should consider a "failure-cost" approach that reflects an effective penalty borne by the agency and by transportation customers due to closure of a severely deteriorated facility. Such a penalty effectively provides a criterion to undertake needed work before the infrastructure reaches a failed state.
- Systems should include budget constraints in cost estimates performed at a network, system, or program level. They also should provide the capability to forecast the annual needed to maintain assets at established condition levels; or, conversely, the condition level that will be attained as a function of constrained budget level.

Scenario Testing Example

Scenario testing can be used to investigate the funds required to achieve a performance target or, conversely, the condition that can be achieved with a given budget level. Figure 8.7 illustrates an example comprising a set of three scenarios that have been analyzed for an example network of 500 bridges using the Pontis® 4.0 bridge management system. Each scenario tests a particular budget level (high, moderate, and none) to preserve the bridge network through a 10-year analysis period. Figure 8.7 plots the condition of the bridge network versus time in years. The network-average bridge condition is gauged by the percent of bridges with Health Index (HI), a measure of bridge structural condition, greater than 75 percent. Plotting the condition level at the end of 10 years versus the corresponding annual budget (the end points in Figure 8.7) results in the relationship between condition and expenditure as shown in Figure 8.8. This graph captures the tradeoff between constant expenditure level and resulting long-term condition. This relationship can be used directly as a guide identifying the expenditure level to meet a specified target condition level. Moreover, Figure 8.8 provides a basis for tradeoffs analyses with other programs (as described in Chapter 6).

Figure 8.7 Example of Budget Scenarios and Effects on Infrastructure Condition

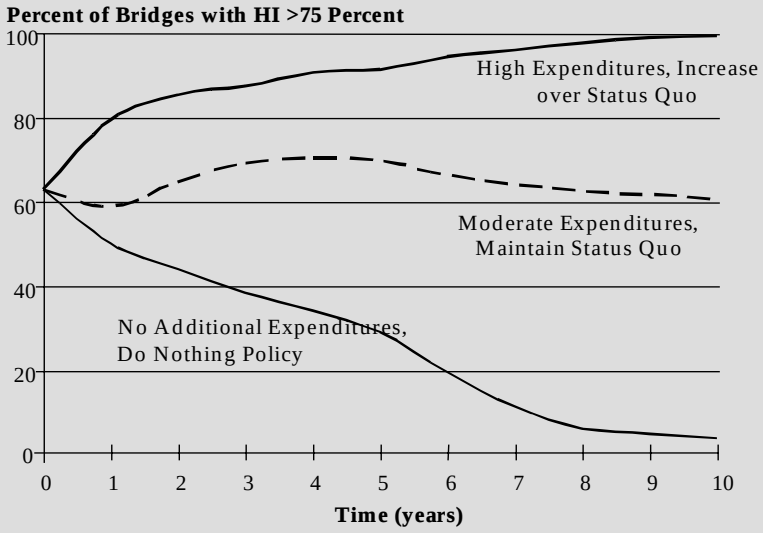
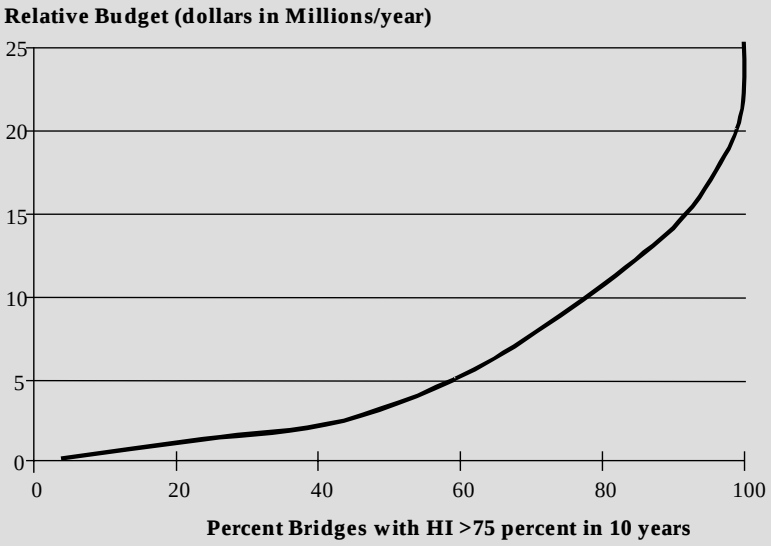


Figure 8.8 Resulting Relationship Between Infrastructure Condition and Needed Expenditure



NEEDS IDENTIFICATION

- Systems should provide the capability to flag the specific locations of assets or individual facilities that do not (or will not) meet one or more minimum standards.
- Systems should provide the capability to identify multiple types of needs occurring in a given location (e.g., deficiencies due to congestion and to pavement condition).
- Systems should provide the capability to estimate the costs of addressing the identified needs using decision rules or automated evaluation and selection of alternative actions.
- Systems should provide the capability to summarize these costs across a variety of dimensions (by type of action, location, type of asset, etc.).
- Systems should provide the capability to easily locate and retrieve information on planned, programmed and pipeline projects in selected locations.

PROJECT, PROGRAM, AND NETWORK-LEVEL EVALUATION OF PROPOSED WORK

- Given a list of candidate projects (which may include a mix of assets and project types), systems should provide the capability to prioritize candidates according to a consistent methodology: e.g., benefit/cost ratio, cost-effectiveness criterion, or other agency criteria, to assist in planning and programming.
- Agencies should develop project evaluation tools that have a consistent set of outputs and outcome measures across project types to allow for evaluation of wide range of alternative approaches.
- Systems should provide the capability to evaluate the life-cycle costs and benefits of a given type of project. In asset preservation, provide the capability to estimate the life-cycle costs associated with different capital/maintenance strategies.
- Systems should provide the capability to calculate performance measures associated with a range of investment levels and distributions (e.g., to support tradeoff analyses).

PROGRAM DELIVERY

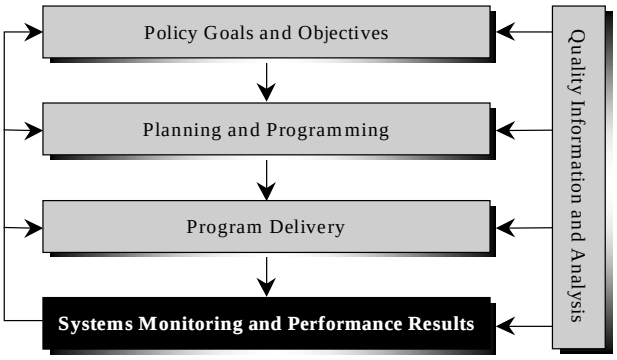
- The systems should summarize information on overall program delivery in terms of cost and time parameters, number of proposed projects completed, and reasons for significant changes.
- Systems should provide the capability to derive or update unit costs and cost models based on actual project or contract cost data.

8.5 SYSTEM MONITORING AND FEEDBACK

8.5.1 OVERVIEW

A critical aspect of information support for asset management occurs in the scheduled monitoring of the transportation system to gather data on how the transportation network infrastructure is performing, compare performance results to intended targets or policy objectives, and provide feedback to individual stages of resource allocation and utilization to identify needed adjustments in policy, procedures, and criteria for future management cycles. Monitoring the performance of the transportation network infrastructure within the asset management framework is illustrated in Figure 8.9.

Figure 8.9 Feedback Loops within Resource Allocation and Utilization



In the context of asset management, system monitoring refers to gathering information on the impact of preservation, improvement, maintenance, and operations programs on the characteristics and behavior of the transportation network. The synonymous terms "system performance monitoring,"

"program performance monitoring," and "performance monitoring" all refer to the same management activity: to determine and report the impacts of transportation programs on the transportation network and the service it provides to its users. These impacts may be in several areas: e.g., the physical condition and integrity of the system, the transportation service provided (which in turn affects the level of mobility and support for economic opportunity), and the effects of system usage on other public policy objectives such as environmental protection, social cohesion, and energy conservation.

There is a corresponding set of measures that can be applied at the same stage in Figure 8.9 to monitor the delivery of the transportation construction, maintenance, and operations programs themselves. These measures, which are discussed in Chapter 7, provide accountability for program accomplishment and communicate program status and progress. These measures can be referred to as "program delivery measures" to distinguish them from measures of transportation system performance. Both sets of measures are relevant to an asset management perspective.

8.5.2 Performance and Delivery Measures

Performance measures are measurable or observable indicators used in system monitoring. They help to communicate system status, impacts of recent program investments, short-term and long-term trends affecting the transportation system, and emerging needs for new investment or updates in policy. They provide a critical linkage between policy goals and planning and programming decisions, and the means to gauge the implications of shifting funds among programs in tradeoffs. The preferred approach is to have quantifiable performance measures, although qualitative measures can serve in certain situations (e.g., in gauging visual appeal of roadsides or facilities, or in characterizing network connectivity or degree of intermodal connections). Delivery measures provide accountability for program accomplishment.

Useful characteristics of performance and delivery measures are as follows:

- A set of measures should track system performance and program delivery in each major program area, and in certain cases by class or type of asset.
- Performance measures should be related to:
  - Policy objectives;
  - Physical condition and system performance; and
  - User benefits and perceptions of system and service quality.
- Performance measures collectively should help explain reasons for changes in transportation system performance, and whether due to program investments and agency services or to other factors (e.g., shifts in transportation demand).Performance measures should reflect transportation impacts that are an integral part of a performance-based budgeting framework.
- Performance and delivery measures should be tracked regularly through inspections, customer surveys, and program status reports, and should be reported regularly to internal and external stakeholders as accomplishments.
- Monitoring of trends over time should help identify needed adjustments in policy and/or planning and programming.

Performance measures are an important element of making an asset management approach work in practical terms. They provide important linkages among the functions shown in Figure 8.9. NCHRP Project 20-60, due to start in 2003, is intended to identify more specifically how performance measures should be selected and applied to meet asset management benchmarks for improved practice.

Performance Measures in a Statewide Transportation Plan

Since 1992, the Oregon DOT's transportation plan has used a set of performance measures based on earlier work by a citizen's group. Examples of these performance measures are "percent of pavements in fair or better condition" and "percent of mileage that experiences low or moderate congestion during peak hours." Each update of the plan includes a set of specific benchmarks against which the implementation of the plan is measured. Progress toward the benchmark criteria is tracked each year using data from the agency's management systems.[12]

8.5.3 FEEDBACK MECHANISMS

Figure 8.9 identifies a number of feedback mechanisms that need to be served by performance and delivery measures. These feedback loops are part of the principle of asset management relating to informed decisions based on objective information. The nature of the information provided by the several feedback loops in Figure 8.9 is as follows:

- **Feedback to Policy Goals and Objectives**. Comparisons of system performance trends to performance targets provides information on the impacts of program investments and the degree to which program objectives have been attained. They also may identify emerging trends that need to be accounted for in future policies and investment priorities. This information can influence future policy formulation and redirect priorities toward emerging needs.
- **Feedback to Planning and Programming**. System performance monitoring helps to quantify the outcomes of recent investment decisions and establish baseline data on system usage and performance for future decisions. This information may influence adjustments or updates to project prioritization criteria. Monitoring and data collection by an agency also can update information on current asset inventory, condition, and performance, and the cost and effectiveness of project treatments and service delivery methods for use in future programming and program delivery decisions. Customer surveys can gauge the public response to construction and maintenance work and the impacts of these investments on system performance. Customer perceptions of the priority of needed improvements and services, and the quality and timeliness by which the DOT accomplishes these efforts, also can be assessed.
- **Feedback to Program Delivery**. Program delivery monitoring and feedback documents whether projects and services have been delivered on time and budget and to the requisite quality. It also can identify problems that require remedy.

8.5.4 ROLE OF INFORMATION TECHNOLOGY

System performance and program delivery measures ideally should be able to be predicted by your agency's management systems or analytic tools, as well as be measurable or observable in the field. This dual capability provides closure in the following aspects of an asset management approach:

- It enables management systems to be used during policy formulation to assess the costs of achieving different levels or targets in performance, and to inform decisions on realistic policy objectives and performance targets.
- It enables the evaluation of alternatives by applying the same performance measures as those that will be used to monitor the impact of the completed project.
- It enables management systems and other analytic tools to inform planning and priority programming decisions, since these processes need to be compatible with policy objectives and associated performance measures and targets.
- It enables management system and other analytic support of program tradeoff analyses.
- It enables IT support of program delivery, including examination of "what if" scenarios regarding project and program adjustments.
- In general, it promotes the integration and fullest use of your agency's considerable

[12] Oregon DOT, Oregon Highway Plan, http://www.odot.state.or.us/tdb/planning/highway, 2002

investment in IT with your day-to-day business processes in all of these areas.

8.6 REPORTING AND DOCUMENTATION

While reporting and documentation are related to information and analytic capabilities and are an element of system performance monitoring and feedback, they are important enough to warrant additional emphasis. The audiences for performance-based information are both external and internal. Internal audiences include agency managers and staff with responsibilities for functions or meeting targets related to asset management. External audiences include public officials, customers, other stakeholders, and the public at large. The scope and detail of reports will vary with the intended audience, but collectively, these reports are an important part of sustaining good infrastructure management practice within the agency, informing stakeholders and the public as to the status and direction of infrastructure management, providing the feedback information needed for effective updating of policy, planning, and programming, and establishing the basis for accountability.

Practices in reporting results and providing accountability are maturing, particularly among agencies that have adopted performance-based concepts in their management approach. Many states provide reports externally (e.g., annually or quarterly), and several are developing semi-automated internal reports in the form of monthly summaries and "dashboards" for executive briefings and decision-making. Examples of "report cards" and other types of status reports for program delivery are given in Chapter 7, and many of the elements discussed in Chapters 5 and 6 (e.g., policy objectives, performance targets, prioritization procedures, tradeoff analyses, the LRTP, and the STIP) are potentially the subjects of reports.

One of the key needs identified in asset management is the strengthening of information and analytic capabilities to support decisions by executives and other senior managers. One mechanism that agencies have undertaken in this regard is the use of "dashboards." Dashboards provide an overview of key indicators and potential problems in transportation system performance. They are built up from the relationship between the strategic objectives that focus on core business areas and the respective performance measures and targets and their organizational "owners." The indicators that are tracked may vary from period to period, reflecting executive priorities, and they are usually on an "exception" basis, using dials or colors to indicate a problem. They rely on readily measurable data (e.g., infrastructure condition).

More generally, asset management encourages more effective reporting from bottom-up to inform high-level decisions more completely and effectively (e.g., using what-if capabilities of management systems), and more effective communication of policy objectives and associated targets from top-down (Figure 2.2). Documentation of key information (whether electronically or in hard copy) establishes an historical record, maintains the time-series data that are used to establish trends, and provides the foundation of objective information that is needed to analyze the consequences of investments, and to identify fundamental changes in infrastructure condition, use, performance, or cost over time. Within this context, asset management encourages the following considerations when updating information and analytic capabilities to support more effective reporting and documentation:

- To update existing analytic systems and tools, and develop of new capabilities, that:
  - Incorporate performance measures and performance targets in decision-support procedures and reports, if they do not already do so;
  - Aggregate or "roll up" network information in a form that is useful to high-level management decisions; and
  - Design reports that clearly indicate the consequences as well as the cost of investment, and give a sense of the relative standings of alternatives that have been considered.
- To incorporate more comprehensive and timely data in reports:
  - Comprehensive data to support identification and evaluation of alternatives and analysis of tradeoffs; and

  - Timely data to be able to collect, compile, and analyze data on the timetable dictated by executive decision-making.

- To indicate more clearly the basis of management accountability for results by delineating the portion of results for which the agency exercises responsibility versus results due to aspects of performance beyond the agency's control; and
- To provide reports that foster communication and coordination with other government agencies, and that inform other key stakeholders and the public.

Asset Management System Implementation Assessment Survey

Asset Management System Implementation

Mission Statement

Recognizing that Asset Management is a process and methodology that UDOT can use to cost effectively deliver an efficient, effective, reliable and safe transportation service; the Mission of the UDOT Asset Management System Implementation is:

- **To put in place the plans, people, processes and products which enable UDOT to implement accepted asset management practices in a timely and cost effective manner;**

And

- **To continually monitor and improve the asset management implementation over time;**

So That

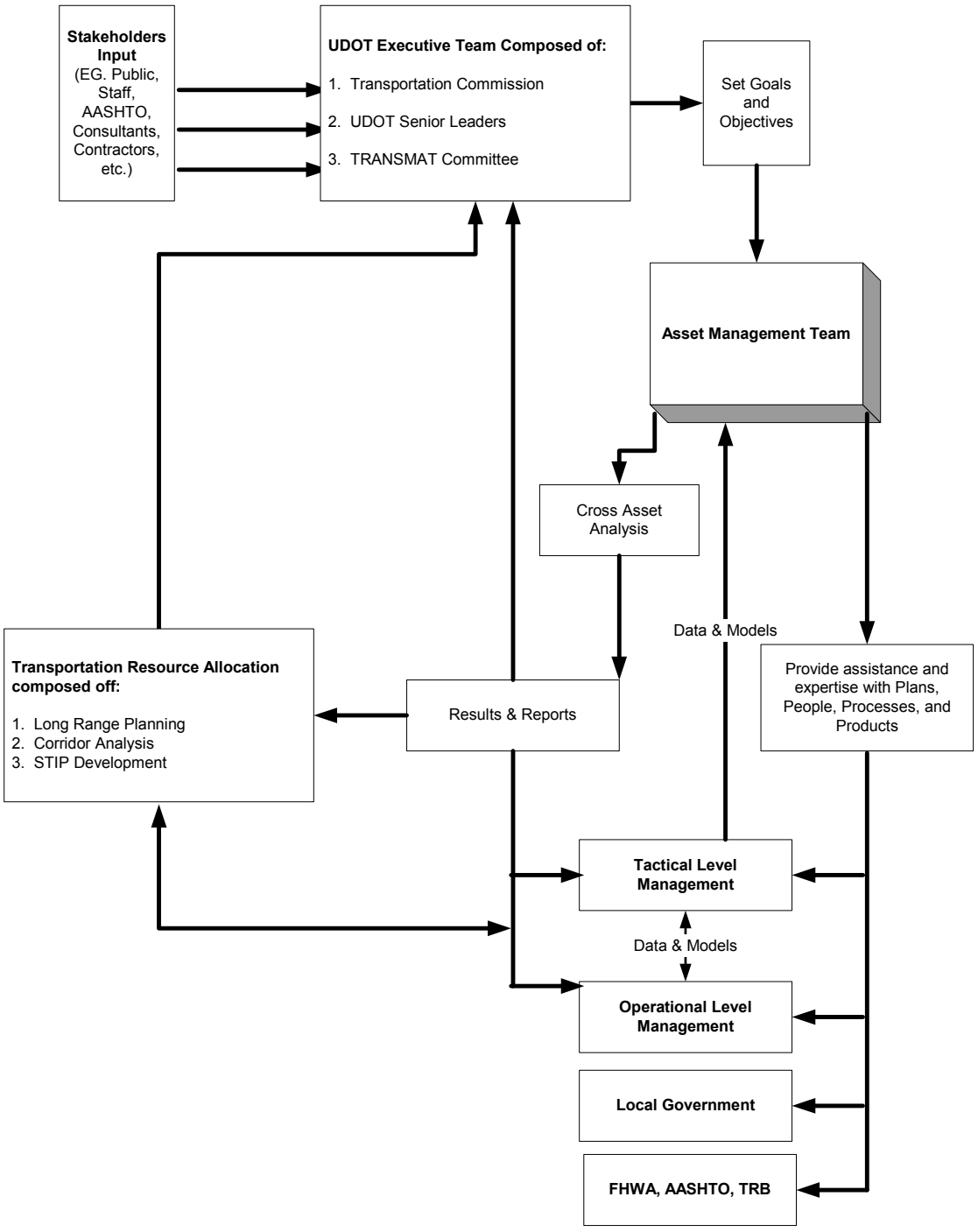
- **Benefits to UDOT in the areas of Accountability, Communication, Risk Management and Financial Efficiency can be realized.**

In three to five year's time UDOT's Asset Management System will be:

- **Integrated: where funding allocation decisions are broad based across various asset categories;**
- **Automated: so that funding allocation decisions are generated in a more systematic, repeatable and objective manner;**
- **Expanded: to include other network assets other than just pavements and bridges;**
- **Accessible: to all UDOT stakeholders through the internet or other communication media.**

The following figure outlines the perceived role of the Asset Management Team within UDOT that corresponds to the mission and vision outlined above.

UDOT's Asset Managements' Team Role



Asset Management Assessment Survey

Recognizing that the Asset Management System Implementation is an on-going process that is refined and enhanced through continual improvement and incremental development, the asset management implementation team is looking for guidance on prioritizing implementation efforts over the next 2 years.

This survey has been designed to help determine the current state of asset management practice within UDOT and the desired level of asset management practice to be achieved within the next few years. The original survey was produced by Cambridge Systematics for the American Association of State Highway and Transportation Officials. It has been modified and enhanced by Deighton and UDOT to better serve the needs of the UDOT Asset Management Implementation Team.

The survey is divided into 5 sections detailing Policy Guidance, Planning and Programming, Program Delivery, Information and Analysis and the Asset Management Implementation itself.

The survey presents several Asset Management Best Practice components and seeks to determine the following for each separate component:

- The extent to which the Best Practice component is implemented within current asset management practice at UDOT. A response of 1 indicates that the best practice component is not implemented within UDOT. A response of 5 indicates that the practice is implemented and well established within UDOT.
- The extent to which the Best Practice component should be implemented in the future based on the respondents opinion of the need for the best practice component. A response of 1 indicates that the implementation of the best practice component is not desired in the future. A response of 5

indicates that the best practice component is highly desired and should be implemented fully within UDOT in the coming years.

- The awareness of the Best Practice component implementation throughout UDOT. This attempts to capture the respondent's impression of how the implementation of the best practice component has been communicated within the department. A response of Low indicates that there has been little communication of the practice so the awareness will be low throughout the department. A response of high indicates that the awareness of the best practice component within UDOT is widespread and communicated on a regular basis.

The following serves as an example of the survey format:

Item	Description		Level of Implementation				
A1.	*Policy guidance supports preservation of existing infrastructure assets.*	Existing Practice	1	2	3	4	(5)
		Desired Practice	1	2	3	4	(5)
		Awareness of Practice	Low		(Mod)		High

In this example, the respondent believes that the Best Practice component is fully implemented within existing asset management practice within UDOT and that the level of implementation should continue in the future. The respondent believes though that there is only Moderate awareness of the policy within UDOT.

A. Policy Guidance

Item	Description		Level of Implementation				
A1.	*Policy guidance supports preservation of existing infrastructure assets.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A2.	*Policy guidance encourages resource allocation and project selection based upon cost-effectiveness or benefit – cost analysis.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A3.	*Policies support a long-term, life – cycle approach to evaluating investment benefits and costs.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A4.	*Policy guidance considers customer perceptions and expectations.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

A. Policy Guidance

Item	Description		Level of Implementation				
A5.	*Our customers contribute to the process that formulates policy goals and objectives.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A6.	*Policy guidance on resource allocation allows our agency sufficient flexibility to pursue a performance based approach.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A7.	*Our agency has a business plan or a strategic plan with comprehensive well-defined goals and objectives to guide resource allocation.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A8.	*Our agency's goals and objectives are linked to specific performance measures and evaluation criteria for resource allocation.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

A. Policy Guidance

Item	Description		Level of Implementation				
A9.	*Our agency estimates the resources needed to accomplish particular objectives as part of policy development.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A10.	*Our agency regularly communicates to customers and other stakeholders our accomplishments in meeting policy objectives.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A11.	*Our agency works with political leaders and other stakeholders to present funding options and consequences as part of our budget proposals.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
A12.	*Policies are communicated in writing and are available for all employees and stakeholders to review at any time.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

A. Policy Guidance

Item	Description
A13.	*Policy clearly defines the characteristics of roadways that should be included in the state transportation network jurisdiction and those roadways that should be owned and maintain by other government agencies.*

	Level of Implementation				
Existing Practice	1	2	3	4	5
Desired Practice	1	2	3	4	5
Awareness of Practice	Low		Mod		High

B. Planning and Programming

Item	Description		Level of Implementation				
B1.	*Our agency's long-range plan includes an evaluation of capital, operational and modal alternatives to meet system deficiencies.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B2.	*Capital versus maintenance expenditure tradeoffs are explicitly considered in the preservation of assets like pavements and bridges.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B3.	*Capital versus operations tradeoffs are explicitly considered in seeking to improve traffic movement.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B4.	*Our agency's long-range plan is consistent with currently established policy goals and objectives.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

B. Planning and Programming

Item	Description		Level of Implementation				
B5.	*Our agency's long range plan includes strategies that are consistent with plausible projections of future revenues.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B6.	*Our agency's long range plan provides clear and specific guidance for the capital program development process.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B7.	*Our agency periodically updates its planning and programming methods to keep abreast of current policy guidance and critical performance criteria.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B8.	*Criteria used to set program priorities, select projects and allocate resources are consistent with stated policy objectives and defined performance measures.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

B. Planning and Programming

Item	Description		Level of Implementation				
B9.	*Our agency's programs are consistent with realistic projections of future revenues.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B10.	*Our agency's programs are based on realistic estimates of costs, benefits, and impacts on system performance.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B11.	*Project selection is based primarily on an objective assessment of relative merits and the ability to meet performance targets.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
B12.	*The preservation program budget is based upon analyses of at least life-cycle costing rather than exclusive reliance on worst-first strategies.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

B. Planning and Programming

Item	Description		Level of Implementation				
B13.	*A maintenance quality assurance study has been implemented to define levels of service for highway and transportation system maintenance.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

			Level of Implementation				
B14.	*Planning and Programming periodically audits the UDOT transportation network to ensure that the network includes only those assets as defined in official Policy regarding UDOT jurisdiction.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

			Level of Implementation				
B15.	*Planning and Programming periodically transfers transportation network assets that do not meet the official Policy for UDOT jurisdiction.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

C. Program Delivery

Item	Description		Level of Implementation				
C1.	*Our agency periodically evaluates the use of alternative delivery options such as maintenance outsourcing, intergovernmental agreements, design- build - maintain and similar options.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
C2.	*Our agency has an incentive program for recognizing or rewarding outstanding performance in improving upon schedule, quality, and cost objectives.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
C3.	*Our agency solicits input from all affected parties to ensure that project scope is consistent with objectives of the project.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
C4.	*Our agency uses well defined program delivery measures to track adherence to project scope, schedule and budget.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

C. Program Delivery

Item	Description		Level of Implementation				
C5.	*Our agency has a well established and functioning process to approve project changes and program adjustments.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
C6.	*When adding projects or changing project schedules, our agency considers effects on the delivery of other projects in the program.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
C7.	*Projects with significant changes to scope, schedule, or cost are reprioritized to ensure that they are still competitive in cost and performance.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
C8.	*Agency executives and program managers are regularly kept informed of program delivery status.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

C. Program Delivery

Item	Description		Level of Implementation				
C9.	*External stakeholders and policy-makers feel that they are sufficiently updated on program delivery status.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

			Level of Implementation				
C10.	*Our agency maintains and uses information on the full unit costs of construction activities.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

			Level of Implementation				
C11.	*Our agency maintains and uses information on the full unit costs of maintenance activities.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

D. Information and Analysis

Item	Description		Level of Implementation				
D1.	*Our agency has a complete and up-to- date inventory of our major assets.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D2.	*Our agency regularly collects data on the condition of our assets.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D3.	*Our agency regularly collects data on the performance of our assets such as (serviceability, ride quality, capacity, operations, and safety improvements).*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D4.	*Our agency regularly collects customer perceptions of asset condition and performance.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

D. Information and Analysis

Item	Description		Level of Implementation				
D5.	*Our agency continually seeks to improve the efficiency of data collection (e.g. through sampling techniques, automated equipment, and other methods appropriate to our transportation service.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D6.	*Our agency continually seeks to improve the quality and accuracy of data collected to make strategic, tactical and operational level decisions.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D7.	*Our agency periodically reviews the data collection policy for each asset to determine the cost effectiveness of the data being collected.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D8.	*Our agency periodically reviews the data collection policy for each asset in various departments to reduce duplication and increase uniformity in data.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

D. Information and Analysis

Item	Description		Level of Implementation				
D9.	*Agency managers and staff at different levels can quickly and conveniently obtain information they need about asset characteristics, location, usage, condition and performance.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D10.	*Our agency has established standards for location referencing that allow us to bring together information for different asset classes.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D11.	*Our agency strictly enforces compliance to location reference standards across decision support tools and departments.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D12.	*Our agency can easily produce reports and maps showing needs and deficiencies for different asset classes and programmed projects.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

D. Information and Analysis

Item	Description		Level of Implementation				
D13.	*Our agency has established data standards to promote the consistent treatment of existing asset - related data and to guide development of future applications.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D14.	*Information on actual work completed and costs is used to improve the cost projection capabilities of our management systems at the strategic, tactical, and operational levels.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D15.	*Information on changes in asset condition over time is used to improve forecasts of asset life and deterioration in our management systems at the strategic, tactical, and operational level.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D16.	*Our agency uses asset management decision support tools to calculate and report actual system performance.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

D. Information and Analysis

Item	Description		Level of Implementation				
D17.	*Our agency uses asset management decision support tools to identify system deficiencies or needs.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D18.	*Our agency uses asset management decision support tools to rank candidate projects for the capital program.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D19.	*Our agency uses asset management decision support tools to forecast future system performance given a proposed program of projects.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D20.	*Our agency uses asset management decision support tools to forecast future system performance under different mixes of investment levels by program category.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

D. Information and Analysis

Item	Description		Level of Implementation				
D21.	*Our agency monitors actual system performance and compares these values to targets projected for its capital preservation program.*	Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D22.	*Our agency monitors actual system performance and compares these values to targets projected for its capital improvement program.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D23.	*Our agency monitors actual system performance and compares these values to projected values for its maintenance and operational program.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High
D24.	*Our agency periodically distributes reports of performance measures relevant to customer and stakeholder satisfaction with transportation system and services.*		Level of Implementation				
		Existing Practice	1	2	3	4	5
		Desired Practice	1	2	3	4	5
		Awareness of Practice	Low		Mod		High

E. Asset Management Implementation

The following survey questions are intended to assist in the definition of the roles and responsibilities of the Asset Management Team within UDOT. A response of 1 indicates that the responsibility for the best practice component belongs to another team within UDOT and a response of 5 indicates that the Asset Management Team will be directly responsible for the best practice component.

The initial questions within this section are intended to confirm the support for the Asset Management Team within UDOT and the Asset Management initiatives being brought forward. These initial questions require a response of Disagree or Agree.

Item	Description	Level of Agreement	
		Disagree	Agree
E1.	*To ensure success and guarantee the benefits of Asset Management, UDOT Senior Leaders will support and fund initiatives by TRANSMAT and the Asset Management Team for a minimum of three years.*		

		Level of Agreement	
		Disagree	Agree
E2.	*The Asset Management team will formulate an improvement strategy and action plan to improve the implementation of asset management within UDOT. TRANSMAT will finalize, approve, fund and support improvement projects throughout the department to accomplish this strategy.*		

E. Asset Management Implementation

Item	Description		Level of Responsibility				
E3.	*The Asset Management team will be responsible for maintaining an asset repository to serve as the official asset register for UDOT.*	Asset Management Team Responsibility	1	2	3	4	5
E4.	*The Asset Management team will be responsible for performing the cross asset analysis and optimization to determine funding allocations at the strategic level.*	Asset Management Team Responsibility	1	2	3	4	5
E5.	*The funding allocations that result from the cross asset optimization will be used in the formulation of the long-range plan.*	Asset Management Team Responsibility	1	2	3	4	5
E6.	*The funding allocations that result from the cross asset optimization will be used in the formulation of the asset preservation plans at the tactical and operational levels.*	Asset Management Team Responsibility	1	2	3	4	5

E. Asset Management Implementation

Item	Description		Level of Responsibility				
E7.	*The Asset Management team will coordinate between the management systems to ensure tactical and operational programs are delivered in conjunction with strategic objectives.*	Asset Management Team Responsibility	1	2	3	4	5
E8.	*The Asset Management team will assist tactical and operational level areas in improving the data and analysis models used at the respective levels and then at the strategic level.*	Asset Management Team Responsibility	1	2	3	4	5
E9.	*The Asset Management team will coordinate the development and implementation of Key Performance Indexes (KPIs) to be used at all levels of analysis.*	Asset Management Team Responsibility	1	2	3	4	5
E10.	*The Asset Management team will coordinate the development and implementation of new analysis techniques and analysis methodologies that can be used at all levels of analysis.*	Asset Management Team Responsibility	1	2	3	4	5

E. Asset Management Implementation

Item	Description		Level of Responsibility				
E11.	*The Asset Management team will coordinate and assist with the implementation of management systems at the operational levels where no existing systems are in place but are desired.*	Asset Management Team Responsibility	1	2	3	4	5
E12.	*The Asset Management team will liaison with the FHWA and other transportation agencies to share information and knowledge to further the development of asset management in UDOT and in the United States.*	Asset Management Team Responsibility	1	2	3	4	5
E13.	*The Asset Management team will liaison with local governments to share information and knowledge to further the development of asset management in Utah.*	Asset Management Team Responsibility	1	2	3	4	5

F. Comments

Please include your name as well as any comments that you may have for the Asset Management Team.

Survey Completed By: _____

Comments: _____

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